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Proceedings

OF

The Florida
STATE HORTICULTURAL SOCIETY

FOR

1949

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Proceedings

OF THE

SIXTY-SECOND ANNUAL MEETING

OF THE

Florida
STATE HORTICULTURAL SOCIETY

HELD AT

Tampa, Florida

November 1st, 2nd and 3rd

1949

Published by the Society

HON. SPESSARD L. HOLLAND

United States Senator and Wartime Governor of Florida; member of Senate Committees on Agriculture and Forestry, and Public Works; Chairman of Public Buildings Subcommittee of Public Works. Senator Holland addressed the Society at the opening meeting.

DR. J. HILLIS MILLER

President of the University of Florida.
Dr. Miller addressed the Society at the opening meeting.

Florida
STATE HORTICULTURAL SOCIETY
OFFICERS ELECT
for
1950

PRESIDENT

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Bradenton

CITRUS SECTION

KINGSWOOD SPROTT
Vice-President
Lake Wales

VEGETABLE SECTION

DR. A. H. EDDINS
Vice-President
Hastings

KROME MEMORIAL INSTITUTE

COL. W. R. GROVE
Vice-President
Laurel

ORNAMENTAL SECTION

ERDMAN WEST
Vice-President
Gainesville

PROCESSING SECTION

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Vice-President
Lake Alfred

SECRETARY

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TREASURER

LEM P. WOODS, Tampa

ASSISTANT SECRETARIES

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DR. F. S. JAMISON, Gainesville
RALPH P. THOMPSON, Winter Haven
BERT LIVINGSTON, Tampa

EXECUTIVE COMMITTEE

DR. J. R. BECKENBACH, *Chm.*, Bradenton
R. S. EDSALL, Vero Beach
DR. F. E. GARDNER, Orlando
GEORGE H. COOPER, Princeton
JACK FAIRCLOTH, West Palm Beach
FRANK L. HOLLAND, Winter Haven
H. A. THULLBERY, Lake Wales

Constitution

Article 1. This organization shall be known as the Florida State Horticultural Society, and its object shall be the advancement of Horticulture.

Article 2. Any person or firm may become an annual member of the Society by subscribing to the Constitution and paying three dollars. Any person or firm may become a perennial member of the Society by subscribing to the Constitution and paying the annual dues for five or more years in advance. Any person or firm may become an annual sustaining member of the Society by subscribing to the Constitution and paying ten dollars. Any person may become a life member of the Society by subscribing to the Constitution and paying fifty dollars. Any person or firm may become a patron of the Society by subscribing to the Constitution and paying one hundred dollars.

Article 3. Its officers shall consist of a President, one Vice President for each section, Secretary-Treasurer, Assistant Secretaries, and Executive Committee of five, who shall be elected by ballot at each annual meeting. These officers shall take their positions immediately following their election. The duties of the Assistant Secretaries shall be outlined and supervised by the Executive Committee.

Article 4. The regular annual meeting of this Society shall be held on the second Tuesday in April, except when ordered by the Executive Committee.

Article 5. The duties of the President, Vice Presidents, Secretary and Treasurer shall be such as usually devolve on these officers. The President, Secretary and Treasurer shall be ex-officio members of the Executive Committee.

Article 6. The Executive Committee shall have authority to act for the Society between annual meetings.

Article 7. The Constitution may be amended by a vote of two-thirds of the members present.

Article 8. A section of the annual program of the Society shall be devoted to the discussion of sub-tropical fruits, exclusive of the commonly grown varieties of citrus fruits. This section shall be known as the *Krome Memorial Institute*. It shall be presided over by a fourth vice president who shall be elected by ballot at each annual meeting of the members in attendance at the Institute. The fourth vice president shall be an ex-officio member of the Executive Committee.

Article 9. The Executive Committee may, at its discretion and on the basis of merit, nominate not to exceed five persons in any one year, for Honorary Membership in the Society. Honorary members shall enjoy all privileges of the Society.

Article 10. A section of the annual program of the Society shall be devoted to the discussion of vegetables and other truck crops. This section shall be known as the *Vegetable Section of the Florida State Horticultural Society*. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

Article 11. A section of the annual program of the Society shall be devoted to the discussion of ornamentals. This section shall be known as the *Ornamental Section of the Florida State Horticultural Society*. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

Article 12. A section of the annual program of the Society shall be devoted to the discussion of processing. This section shall be known as the *Processing Section of the Florida State Horticultural Society*. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

By-Laws

1. The Society year shall be coextensive with the calendar year, and the annual dues of members shall be three dollars.

2. All bills authorized by the Society or its Executive Committee, for its legitimate expenses, shall be paid by the Secretary's draft on the Treasurer, O.K'd by the President.

3. The meetings of the Society shall be devoted only to Horticultural topics, from scientific and practical standpoints, and the presiding officer shall rule out of order all motions, resolutions and discussions tending to commit the Society to partisan politics or mercantile ventures.

4. All patron and life membership dues and all donations, unless otherwise specified by donor, shall be invested by the Treasurer in United States Government bonds. The earnings from these bonds shall be left as accrued values or reinvested in United States Government bonds of a guaranteed periodical value unless it is ordered by the Executive Committee or the Society that such earnings can be made available for operating expense. Receipts from perennial membership dues shall be placed on deposit at interest by the Treasurer. Only three dollars ($3.00) from each perennial membership fee shall be available during any calendar year for payment of operating expenses of the Society.

MEMBERSHIP LIST

HONORARY MEMBERS

Fairchild, Dr. David, Coconut Grove
Haden, Mrs. Florence P., Coconut Grove
Hastings, H. C., Atlanta, Georgia.
Henricksen, H. C., Eustis
Holland, Spessard L., Bartow
Hume, Dr. H. Harold, Gainesville
Lipsey, L. W., Blanton
Mayo, Nathan, Tallahasee
Robinson, T. Ralph, Terra Ceia
Swingle, Dr. W. T., Washington, D. C.

PATRON MEMBERS

American Agricultural Chemical Company, Pierce
American Fruit Growers, Inc., Maitland
Angebilt Hotel, Orlando
Armour Fertilizer Works, Jacksonville
Buckeye Nurseries
Chase & Company, Sanford
Coral Reef Nurseries Co., Homestead
Deerfield Groves, Wabasso
Dcering, Charles
Exchange Supply Company, Tampa
Exotic Gardens, Miami
Florida Citrus Exchange, Tampa
Florida East Coast Hotel Co., St. Augustine
Florida Grower Publishing Co., Tampa
The Fruitlands Co., Lake Alfred
Gardner, P. C., Lake Alfred
Glen St. Marys Nurseries Co., Glen St. Marys
Gulf Fertilizer Co., Tampa
Hastings, H. G. Co., Atlanta, Georgia
Hillsboro Hotel, Tampa
Klemm, A. M. & Son, Winter Haven
Lake Garfield Nurseries, Bartow
Manatee Fruit Company, Palmetto
Mills The Florist, Jacksonville
Nocatee Fruit Co., Nocatee
Oklawaha Nurseries Co., Inc., Lake Jem
Southern Crate Manufacturing Assn.
Stead, Lindsay, Box 809, Ft. Pierce
Thomas Advertising Service
U. S. Phosphoric Products, Division Tennessee Corp., 61 N. Broadway, New York, N. Y.
U. S. Phosphoric Products, Division Tennessee Corp., Box 3269, Tampa
Van Fleet Co., Winter Haven
Wilson & Toomer Fertilizer Co., Jacksonville

LIFE MEMBERS

Agricultural Experiment Station, Puerto Rico
Albertson Public Library, Orlando
Allenbrand, Alfred, Box 288, Frostproof
Alderman, A. D., Bartow
Andrews, C. W., John Crerar Library, Chicago, Illinois
Barber, C. F., Macclenny
Bartlum, W. Leonard, Florida Agricultural Supply Co., Orlando
Berger, Mrs. E. W., Gainesville
Bouis, Clarence G., Box 6, Ft. Meade
Bringham, M. S., Micco
Britt, John F., Ft. Pierce
Brown, A. C., Gainesville
Bullard, Henry P., Bullard & Sprott, Lake Wales
Carnegie, Mrs. T. M., Fernandina
Champlain, A. E., R3. No. 1, Palmetto
Chase, Josua C., Winter Park
Chidester, D. D., 446 Painter Ave., Whittier, California
Christiancy, Cornelius, Port Orange
Clement, Waldo P., Georgiana
Conner, Wayne E., New Smyrna
Cook, R. F., Leesburg
County Agent, Orange County, Orlando
Crutchfield & Woolfolk, Pennsylvania Produce Bldg., Pittsburgh, Pennsylvania
Dunedin Public Library, Dunedin
Ellsworth, Wilma J. (Miss), Rt. No. 1, Dade City
Fairchild, Dr. David, Coconut Grove
Fugazzi, John, Fugazzi Brothers, Clearwater
Gifford, Dr. John, Coconut Grove
Guest, Mrs. Amy, N. Ocean Blvd, Palm Beach
Haden, Mrs. Florence P., Coconut Grove
Hakes, L. A., Box 771, Orlando
Hastings, H. G., 16 W. Mitchell St., Atlanta, Georgia
Henricksen, H. C., Box 1045, Eustis
Hernandez, Pedro, 108 Cienfuegos, San Fernando, Cuba
Hollingsworth, G. S., Arcadia
Hume, H. Harold, Gainesville
Iowa State College Library, Ames, Iowa
Jacocks, A. J., Winter Haven
Lassen, H. C., Garden Spring Terrace, Saratoga, California
Lauman, G. N., Ithaca, N. Y.
Leonard, George V., Hastings
Manatee Fruit Co., 1st National Bank Bldg., Tampa
Martin, A. Wm., Box 36, Sebastian
Mathews, E. L., Plymouth
McCarty, B. K., Eldred
McCarty, Mrs. C. T., Eldred
Merritt, Dr. J. C., 297 Sherman St., St. Paul, Minnesota
Michael, A. B., Wabasso
Montgomery, Robert H. (Col.), Coconut Grove
Montgomery, Mrs. Robert H., Coconut Grove
Morrell, Albert, 613 Highlands St., Orlando
Mountain Lake Corporation, Lake Wales
O'Byrne, Frank M., Lake Wales
Ohmer, C. J., West Palm Beach
Olivebaum, J. E., Clermont
Pedersen, W. L., Winter Haven
Pennock, Henry, Sr., Jupiter
Phillips, Dr. P. & Sons, Orlando
Phipps, John S., N. Ocean Blvd., Palm Beach
Phipps, H. C., N. Ocean Blvd., Palm Beach
Phipps, Howard, Delray Beach
Pike, W. N., Blanton
Plymouth Citrus Growers Assn., Plymouth
Prosser, Lew, Plant City
Raulerson, J. Ed, Arcadia
Reasoner, N. A., Bradenton
Reid, W. C., Largo
Rhode, H., Sebring
Ricketson, Mrs. M. C., "Grayfield," Fernandina
Sample, J. W., Haines City
Sandlin, A. R., Leesburg
Schuman, Albert, Sebastian
Sellards, Dr. E. H., State Geologist, Austin, Texas
Sloan, G. D., Box 1021, Tampa
Stanton, F. W., Dock & Walnut Sts., Philadelphia, Pennsylvania
Stead, Lindsay, Box 809, Ft. Pierce
Stevens, Edmund, Verge Alta, Puerto Rico
Stuart, L. E., Montemorelos, Mexico
Taber, Mrs. George L., Glen St. Marys
Taylor, J. S., Largo
Thomas, Jefferson, Gainesville
Todd, E. G., Avon Park
Towns, Thomas R., Holguin, Cuba
Trelease, Wm., University of Illinois, Urbana, Illinois
Trueman, Roy B., Trueman Fertilizer Company, Jacksonville
Von Borowsky, Miss Lisa, Brooksville
Wilson & Toomer Fertilizer Co., Box 4459, Jacksonville
Wirt, E. L., Box 144, Babson Park
Woods, L. R., Tampa
Yothers, W. W., 457 Boone St., Orlando

SUSTAINING MEMBERS
As of May 18, 1950

Adams, C. W. Estate, Incorporated, Lake Alfred
Adams Groves, Auburndale
Adams Packing Association, Inc., Box Drawer "B," Auburndale
American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y.
American Fruit Growers, Incorporated, Ft. Pierce
Associated Seed Growers, Incorporated, E. B. Clark, Mgr., Walcaid Bldg., Bradenton
Atlee Burpee Co., W., Sanford
Babb, Herbert A., Gulf Fertilizer Co., Umatilla
Barber, Bascom D., V. Pres., Wilson & Toomer Fert. Co., Box 685, Clearwater
Bellinger, B. W., U. S. Phosphoric Products, Division Tennessee Corp., Box 3269, Tampa
Bellows, Dr. J. M., Hector Supply Co., Miami
Ben Hill Griffin, Inc., Avon Park
Bergstrom Trading Co., Inc., 233 Broadway, New York 7, N. Y.
Bland, W. T., Lake Jem
Boltin, H. H., Pasco Packing Co., Dade City
Boots, V. A., Belle Glade
Brady, R. C., NACO Fertilizer Co., Titusville
Brooks, J. R., Box 36, Homestead
Broward Grain & Supply Co., Inc., Vincent Giglio, Ft. Lauderdale
Browder, David, Box 310, Arcadia
Bryan, L. T., Fosgate Growers Coop., Box 2673, Orlando
Burrichter, A., Coconut Grove, Miami
Caine, M. A., Tennessee Corp., 61 Broadway, Room 1824, New York 6, N. Y.
California Spray-Chemical Corp., Box 1231, Orlando
Campbell Farms, Inc., John W., Goulds
Carleton, R. T., Plymouth
Cartledge, Raymond H., Mgr., Cartledge Fertilizer Co., Cottondale
Chase, Randall, Box 291, Sanford
Chester Groves Company, City Point
Citrus Culture Corporation, Mt. Dora
Clark, John D., Waverly
Clark, S. W., Mgr., Agri. Dept., Texas Gulf Sulphur Co., 1002-2nd National Bank Bldg., Houston 2, Texas
Clark, W. L., Fruit Company, Jacksonville
Clinton Foods, Inc., Dunedin
Cocks, Henry J., Trueman Fert. Co., Box 1175, Mt. Dora
Conkling, W. Donald, Citrus Culture Corp., Mt. Dora
Coronet Phosphate Co., Plant City
Crum, H. M., International Minerals & Chemical Corp., 908 Mortgage Guarantee Bldg., Atlanta 3, Ga.
Dabney, B. G., Coronet Phosphate Co., Plant City
Dancy, R. D., Jackson Grain Co., Cass & Ashley Streets, Tampa
Darner, F. W., U. S. Phosphoric Products, Division Tennessee Corp., Box 3269, Tampa
Deerfield Groves Company, Wabasso
DiGiorgio Fruit Corp., Winter Haven
Dixie Lime Products Co., Box 578, Ocala
Dolomite Products, Incorporated, Box 578, Ocala
Domino Citrus Association, Inc., Box 179, Bradenton
Dorn, H. W., Box 107, S. Miami
Dozier, G. L., NACO Fert. Co., Box 232, McIntosh
Duda, A., Jr., A. Duda & Sons, Oviedo
Duda & Sons, A., Oviedo
Duda, Ferdinand, A. Duda & Sons, Oviedo
Dundee Citrus Growers Association, Dundee
Dutton, Frank F., Jr., Mt. Dora
Dye, Alfred M., Everglades Fert. Co., Box 821, Ft. Lauderdale
Dye, John E., Jr., Everglades Fert. Co., Box 821, Ft. Lauderdale
Eaton, Julian S., 4055 Douglas Rd., Miami
Edsall, Henry J., The Inslee Grove, Bradenton
Edsall, R. S., 1828 28th Ave., Vero Beach
Everglades Fertilizer Co., Box 821, Ft. Lauderdale
Everglades Produce Company, South Bay
Faircloth Truck-Tractor Company, 2829 S. Dixie, West Palm Beach
Florence Citrus Growers Association, Florence Villa
Florida Agricultural Research Institute, Box 392, Winter Haven
Florida Citrus Canners Cooperative, Lake Wales
Florida Citrus Exchange, Box 2349, Tampa 1
Florida Citrus Production Credit Association Box 2111, Orlando
Florida Citrus Products Cooperative, R. K. Cooper, Florence Villa
Florida Dolomite Company, Pembroke
Florida Farm Bureau Federation, Washington St. Arcade, Orlando
Florida Fruit Growers, Inc., W. H. Mouser, Pres., Davenport
Florida Fruit & Vegetable Association, 29 S. Court St., Orlando
Fortner, J. E., Citrus Culture Corp., Mt. Dora
Fosgate Growers Coop., Box 2673, Orlando
Friend, Lewis, Pahokee
Frost-Pac Inc., Haines City
Fudge, Dr. B. R., Horticulturist, Wilson & Toomer Fert. Co., P. O. Drawer 4459, Jacksonville
Glade & Grove Supply Company, Box 198, Princeton
Grant, A. J., 259 Scotland St., Dunedin
Green, William F., Wilson & Toomer Fert. Co., P. O. Drawer 4459, Jacksonville
Greenwood Products Company, Graceville
Growers Fertilizer Cooperative, Lake Alfred
Gulf Fertilizer Company, Box 2721, Tampa
Guy D. Austin Company, Miami 35
Hagadorn, D. L., Jackson Grain Co., Cass & Ashley Sts., Tampa
Hagar, Jack, Fosgate Growers Coop., Box 2673 Orlando
Haines City Citrus Growers Association, Haines City
Haines City Heights, Inc., Haines City
Haley, E. Allen Jr., 805 Underhill Drive, Rt. No. 4, Box 632, Orlando
Hawkins, Howard, Box 445, St. Augustine
Heller Brothers Packing Company, Winter Garden
Hicks, W. B., V. Pres., Wilson & Toomer Fert. Co., P. O. Drawer 4459, Jacksonville
Hinson, Alvin H., Box 868, Plant City
Holland, Frank L., 324 Ave. B., N. E., Winter Haven
Holtzberg, Bertha, 36 Central Park S., New York 19, N. Y.
Holtzberg, Fred, 132 N. 12th St., Ft. Pierce
Horton, W. D., Collins Feed & Supply Co., N. E. 94th St., & FEC Railway, Miami 38
Howard Fertilizer Co., Orlando
Howard, J. D., Howard Fert. Co., Orlando
Howard, R. M., Howard Fert. Co., Orlando
Howell, Morton, Waverly Growers Coop., Lake Wales
Hunt, D. A., Florida Citrus Canners Cooperative Lake Wales
Immokalee Growers, Inc., J. T. Gaunt, Vice Pres., Immokalee
Jackson Grain Company, Cass & Ashley Sts., Tampa
Jackson, R. D., Jackson Grain Company, Cass & Ashley Sts., Tampa
Jamison, J. R., Deerfield Groves Co., Wabasso
Jones, R. S., V. Pres., Wilson & Toomer Fert. Co., P. O. Drawer 4459, Jacksonville
Juice Industries, Inc., Dunedin
Jungle Gardens, Sarasota
Kilgore Seed Company, Plant City
Kime, C. D. Jr., Waverly Growers Coop., Waverly
Kinard, R. R., Gulf Fertilizer Co., Box 607, Homestead
King, Battey, Naples
Kinsey, L. P., Box 878, Winter Haven
Kirtley, A. G., Dundee Citrus Growers Assn., Box 1121, Winter Haven
Klee, W. H., NACO Fertilizer Co., Jacksonville 1
Klemm, A. M., & Son, Winter Haven
Laird, Norman N., Waverly Growers Coop., Waverly
Lake County Citrus Sales, Inc., Bruce Floyd, Leesburg
Lake Region Packing Association, Tavares
Lee, C. S., Box 225, Oviedo
Lesley, John T., Haines City Citrus Growers Assn., Haines City
Lins, E. W., American Fruit Growers, Inc., Fee Bldg., Ft. Pierce
Lucas, Glen H., Mgr., Peninsular Fert. Works, Box 2989, Tampa 1
Lyons Fertilizer Co., Box 310, Tampa
Manatee Fruit Company, Box 160, Palmetto
Mance, H. R., Kilgore Seed Co., Plant City

Marrs, G. F., Superior Fert. Co., 914½ McBerry, Tampa
Matheson, Hugh M., 418 S. W. 2nd Ave., Miami 36
Mathews, E. L., Plymouth
Mathias, Arthur C., Haines City Citrus Growers Assn., Haines City
Mathias, A. F., Superior Fert. Co., Box 183, Lake Hamilton
Maxcy, L. Inc., Frostproof
Maxwell, Lewis, Jackson Grain Co., Cass & Ashley Sts., Tampa
Menninger, Edwin A., Stuart
Mershon, Claud C., Fosgate Growers Coop. Box 2673, Orlando
Messec, Murrel, Box 587, Bradenton
Michael, A. B., Deerfield Groves Co., Wabasso
Miller, Leon W., A. Duda & Sons., R. No. 6, Orlando
Mitchell, Edward C., Citrus Culture Corp., Mt. Dora
Mount Dora Growers Cooperative, Mt. Dora
MacDonald, R. M., Chester Groves Co., City Point
McLain, L. Rogers, Gulf Fert. Co., Box 2721, Tampa 1
McLane, W. F., Lyons Fert. Co., Box 310, Tampa
McSweeney, W. M., Gulf Fert. Co., Box 2721, Tampa 1
NACO Fertilizer Company, Jacksonville
Nicholson, W. A., 3419 Granada Blvd., Coral Gables 34
Oak Hill Citrus Growers Association, Daytona Beach
Oslo Citrus Growers Association, Oslo
Palm Harbor Citrus Growers Association, Palm Harbor
Pasco Packing Company, Dade City
Paul B. Dickman Farms, Ruskin
Pederson, W. C., Waverly
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Perrin & Thompson, Inc., Box 1000, Winter Haven
Phillips, Howard, Dr. P. Phillips Companies, Box 3753, Orlando
Phillips, Dr. P. Companies, Box 3753, Orlando
Pinellas Growers Assn., Clearwater
Pinkerton, J. B., Chester Groves Co., City Point
Plummer, J. K., 900 Roosevelt Highway, College Park, Ga.
Plymouth Citrus Growers Association, Plymouth
Pollard, Rox, Box 500, Auburndale
Preston, W. H., Manatee Fruit Co., First National Bank Bldg., Tampa
Price, R. C., Fla. Agricultural Supply Co., Box 658 Jacksonville 1
Prine, R. H., Box 85, Terra Ceia
Producers Supply, Incorporated, Palmetto
Raoul, Loring, Box 871, Sarasota
Richardson, E. G., 235 Indian River Drive, Ft. Pierce
Richardson, D. K., 2664 19th St., Vero Beach
Rickborn, J. H., Lyons Fert. Co., Box 310, Tampa
Robinson, R. D., Dr. P. Phillips Companies, Box 3753, Orlando
Ross, M. J., Box 388, Jacksonville
Rothwell, A. D., Superior Fertilizer Co., 1407 Hesperides, Tampa
Rowe, Estelle E., Florida Fruit Growers, Inc., Davenport
Rowe, W. Mercer Jr., Flag Sulphur & Chemical Co., 1007 Wallace S. Bldg., Tampa 2
Rudasill, S. J., Box 151, Sebring
Ruskin Vegetable Distributors, Ruskin
Ryall, N. B., Deerfield Groves Co., Wabasso
Ryburn, Alexander W., Box 977, Vero Beach
Sachs, Ward H., Box 3588, Orlando
Sample, J. G., Buccaneer's Roost, Naples
Sample, James M., Lyons Fertilizer Co., Box 310, Tampa
Schneck, H. W., Kilgore Seed Co., Plant City
Seidel, G. A., Box 7, Gotha
Sheffield, J. R., Cororet Phosphate Co., 19 Rector St., New York 6, N. Y.
Shields, J. C., Domino Citrus Association Inc., Box 179, Bradenton
Skinner, B. C., Dunedin
Skinner, F. L., 379 Monroe Street, Dunedin
Sligh, S. J. & Company, Orlando
Sloan, G. D., Box 1021, Superior Fert. Co., Tampa
Slough Grove Company, Inc., Dade City
Smith, F. M., Howard Fert. Co., Orlando
Smith, Herbert A. Jr., 1019 Lancaster Drive, Orlando
South Lake Apopka Citrus Growers Association, Oakland
Snively Groves, Inc., W. W. Giddings, Polk Pkg. Assn., Box 1312, Winter Haven
Sparkman, J. K., U. S. Phosphoric Products, Division Tennessee Corp., Box 3269, Tampa
Speights, J. A., Everglades Fert. Co., Box 821, Ft. Lauderdale
Spencer, T. C., Haines City
Stewart Packing Cooperative, Box 324, Auburndale
Studstill, Frank W. Co., Wauchula
Superior Fertilizer Company, 47th St. & Broadway Ave., Tampa
Swann, Tom B., Box 232, Winter Haven
Swartsel, Ross V., A. Duda & Sons, Box 15, Lake Jem
Thomas, Wayne, Box 831, Plant City
Thornton, R. P., Box 2880, Tampa
Tilden, A. M., Box 797, Winter Haven
Tilden, L. W., Winter Garden
Tuckett, Norman, Sylvan Shores, Mt. Dora
U. S. Phosphoric Products, Division Tennessee Corporation, Box 3269, Tampa 1
Van Horn, M. C., Fla. Agri. Supply Co., Box 658, Jacksonville 1
Virginia-Carolina Chemical Corp., Orlando
Wakelin, G. M., Box 144, Tavares
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Ward, W. F., Box 177, Avon Park
Waring, W. L. Jr., Lyons Fert. Co., Box 310, Tampa
Waverly Fertilizer Works, Waverly
Waverly Growers Cooperative, Waverly
Wedgworth, H. H. Estate, Belle Glade
Wedgworth, Ruth S., Belle Glade
Weeks, Inman W.
Westlake, E. H., Tennessee Corp., 61 Broadway, Room 1824, New York 6, N. Y.
Wetumpka Fruit Company, Hastings
Wheeler Fertilizer Company, Oviedo
Whitfield, Charles S., Amherst Apts., Orlando
Wilson, Homer A., Gulf Fert. Co., Box 746, Ft. Pierce
Wilson & Toomer Fertilizer Company, P. O. Drawer 4459, Jacksonville
Wingfield, Chandler R., Gulf Fert. Co., Box 919, Avon Park
Winston, Dr. J. R., U. S. D. A., 415 N. Parramore, Orlando
Winter Park Land Company, 128 Park Ave. S Winter Park
Wolfe, J. C., Box 310, Tampa
Wood, Wade W., Gulf Fert. Co., Box 634, DeLand
Woods, Fred J., Gulf Fert. Co., Box 2721, Tampa 1
Woods, J. Albert, Pres., Wilson & Toomer Fert Co., P. O. Drawer 4459, Jacksonville
Woods, Lem P., Gulf Fert. Co., Box 2721, Tampa 1
Wray, Floyd L., Flamingo Groves, Inc., Box 1782, Ft. Lauderdale
Yager, Alonzo, Waverly Growers Coop. ,Waverly
Yandre, Thomas E., Farm & Home Machinery, Inc., Box 2547, Orlando

ANNUAL MEMBERS
As of May 18, 1950

Adkinson, W. Hal, Minneola
Agricultural Research Station, Library, Box 15, Rehoboth, Israel
Alexander, J. F., Box 154, Bartow
Alexander, Taylor R., University of Miami, Miami
Alford, A. B. Jr., Sanford
Allen, E. J., 2150 N. W. 17 Ave., Miami
Allen, Ralph F., 1068 Lake Hollingsworth Drive, Lakeland
Allison, F. E., Box 527, Tifton, Georgia
Allison, R. V., Everglades Experiment Station, Belle Glade
American Cyanamid Company, 30 Rockefeller Plaza, New York 20, N. Y.
American Potash & Chemical Corp., Atlanta, Georgia
American Potash Institute, American Chemical Society Building, 1155 16th Street, Washington 6, D. C.
Andrews, W. R. E., 1505 Race Street Philadelphia 2, Pa.
Arey, Philip S., Monteverde
Arzave, Genaro, P. Mier 328 Ote., Monterey, N. L. Mexico
Atkins, C. D., Box 443, R. 1, Winter Haven
W. Atlee Burpee Company, Sanford

Ausley, P. C., Potash Co. of America, 50 Broadway, New York, N. Y.
Ayers, Ed L., County Agent, Bradenton
Backus, F. E., Box 283, Frostproof
Bair, Roy A., Everglades Experiment Station, Belle Glade
Ballentine, C. C., Box 3751, Orlando
Barber, B. D., Box 685, Clearwater
Barksdale, D. N., Box 2567, Mulberry
Barnett, Joe P., c/o American Fruit Growers, Inc., Ft. Pierce
Baskin, J. L., 1230 Golden Lane, Orlando
Bass, C. A., 82 N. W. 34th St., Miami
Beckenbach, Dr. J. R., Agri. Expt. Sta., Gainesville
Beernalter, A., Rt. No. 3, Box 300, Ft. Pierce
Beisel, C. G., Florida Citrus Canners Corp., Box 112, Lake Wales
Benitez, Lic. Jose, Edificio La Nacional, 311, Monterrey, N. L. Mexico
Bennett, Charles A., 1825 N. W. 21st St., Miami 37
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PROCEEDINGS OF THE FLORIDA STATE HORTICULTURAL SOCIETY 1949

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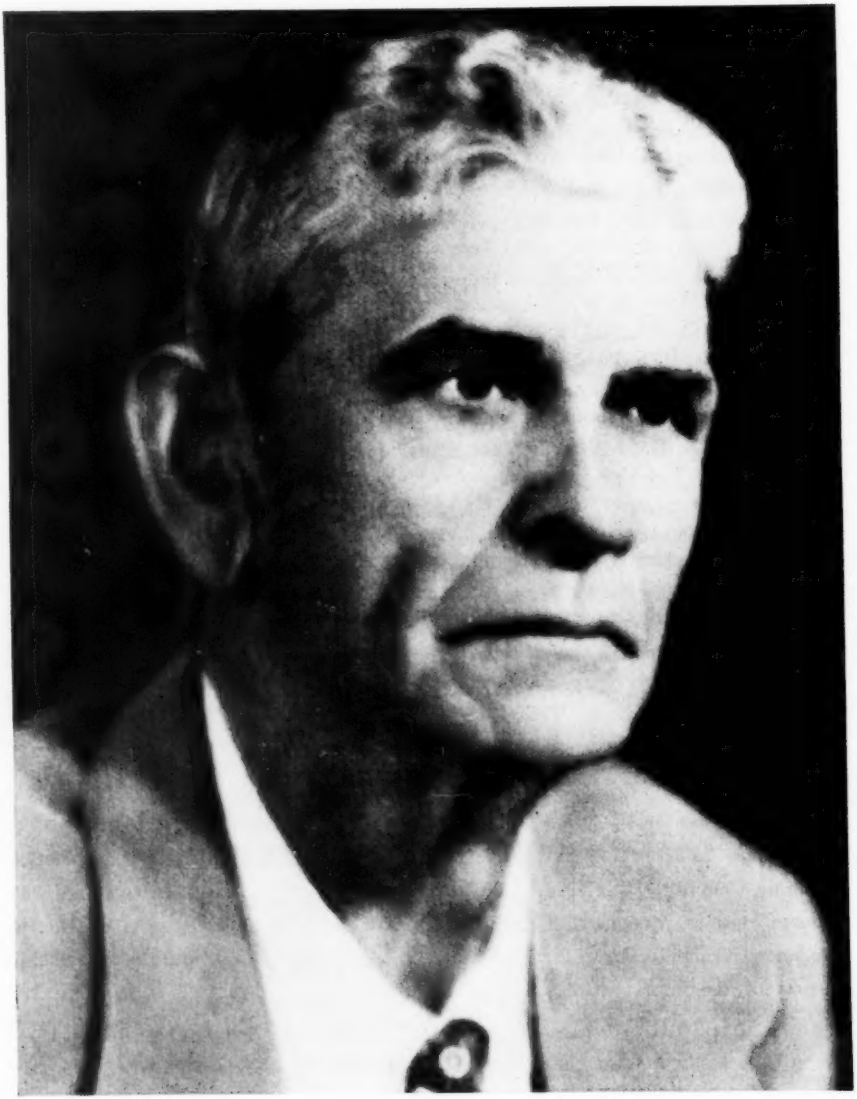

FRANK STIRLING
1878 – 1949

PRESIDENT'S ANNUAL ADDRESS

FRANK STIRLING
Davie

From the time since Dudley W. Adams, first President of this Society, who addressed this group in 1888 it has become the duty of the President, at each annual meeting to present to you an address. The subjects selected by the various Presidents have covered a great many topics. In fact if all of the President's addresses were compiled in book form, that alone would make an exceedingly interesting book which would cover a very great deal of Florida's horticultural history.

I don't think it would be out of line at this time to mention the names of the Presidents of this Society who have presided during the past sixty-one years since its organizational meeting at Ocala—thirteen of them, fourteen including myself. I am listing their names in accordance with their terms of service—Dudley W. Adams, Geo. L. Tabor, C. T. McCarty, P. H. Rolfs, W. C. Richardson, H. Harold Hume, L. B. Skinner, John S. Taylor, C. W. Lyons, Chas. I. Brooks, H. C. Hendricksen, F. M. O'Byrne and Wm. Ward. While most of these men served for more than one year each, the honor of holding the Presidency for the most number of years goes to H. Harold Hume who served from 1910 until 1922, a period of thirteen years. Dudley Adams, the first President, served nine years.

Throughout the history of this Society the yearly Proceedings have recorded the many changes and advancements along the lines of horticulture and other phases of agriculture. These changes have been for the improvement and betterment of the state. Many of these changes were necessarily made as a result of some natural disaster, for instance, prior to the Big Freeze of 1894-95, King Orange had held forth for a number of years. At that time but few had ever thought to try to grow any thing other than oranges and when the groves were frozen to the ground most of the growers gave up, abandoned their property and left the country leaving only the most hardy to carry on. Thereafter, for the next decade or two turpentine became king. In the meantime those horticultural pioneers who remained engaged themselves in trying to see if something other than citrus could be profitably grown, men who felt that Florida soil held secrets which when ferreted out would again put the state on a profitable basis. These men, all of the type indicated by those who have constantly strived for knowledge of what the soil could do soon began to show results, for instance word was spread that in the Sanford area celery could be grown about as well as at Kalamazoo and reports of big profits per acre were made. Then at Hastings, over in St. Johns County, fortunes were being reportedly made in growing Irish potatoes. Still later in the Manatee County area, the Lake Okeechobee country and the East Coast, carloads and even train loads of winter grown truck crops began rolling to northern markets.

But few of you remember seeing in the northern portion of the state, as you rode along on the train from Jacksonville to Pensacola, the carcases of many, many dead pear orchards. Many years ago hundreds of acres of soft skinned pears were planted and that industry began to look promising, but not for long for the fire blight of pears, a deadly disease, made its appearance which finally destroyed that industry. About the same time and in the same area a tremendous effort was made to establish the business of growing Satsuma oranges, figs and Japanese persimmons, but for various difficulties, mainly freezes and disease, those industries were prevented from amounting to anything really important. But the wreaking of these horticultural endeavors did not stop the growers from going ahead and experimenting with other crops. In this same area, today, may be seen many, many acres of Tung tree orchards (43,750 acres, 3 million trees, 21,500 tons of dried nuts, 6 million pounds of oil) yielding a profitable return in Tung Oil to the growers. This, just another example of diligent delving into

possibilities for growing crops which were unthought of before natural disasters undid those that had been unsuccessful before.

Until recent years this Society has stressed the citrus phase of horticulture, had concentrated upon the need for producing more and better citrus fruits, but today the great variety of agricultural products becoming of economic importance makes it imperative to change the original scope which was much narrower than it is today. The original thought of the founders of this Society was to make it apply almost exclusively to orange growing, to citrus fruits and their allied subjects. But as the years have come and gone its scope has been considerably widened so that now it covers not only tropical but sub-tropical fruits, vegetables and many of the fruits of the temperate zone. This enlargement of its sphere has injected into it new relations and new problems.

The programs of the Society necessarily required the addition of several branches other than citrus. You will note that the PROCESSING SECTION of the Society dealing with the modern manner of handling processed fruits, an industry in itself that has practically revolutionized the marketing end of the industry, has a section to itself. The vast expanding of the production of winter grown truck crops has necessitated the establishing of the VEGETABLE SECTION. The many new varieties of tropical and sub-tropical fruits that are now being tried out in the state have made it advisable for the KROME MEMORIAL SECTION to be added and finally, the ORNAMENTAL SECTION dealing with ornamental plants such as vines, shrubs and trees used in landscaping and beautifying homes and estates. This all tends to prove that this Society has been and is trying to improve the lot of its farmers and fruit growers through practical and scientific investigations and dissemination of knowledge. The Society now reminds me of the American Association for the Advancement of Science, a national organization which has over a score of branch sections each one dealing with its own particular subject.

As President of your Society I want to say that we are pleased to receive you here at this meeting, because of the fact that you are either interested or engaged in the first calling of man, and which must, of necessity, be the last in which he will be engaged—namely, to till the soil and nurse the tree. As a rule you have not received the proper proportion of the profits of your labors regardless of the fact that out of the earth come all riches. As stated before the endeavor of this Society is to try to learn not only how to grow more and better fruit and produce but how to transport and market it most profitably.

To give vent to the thought that has been growing in our minds for some years, that the most vital and far reaching questions now calling for solution by Florida producers were not so much cultural questions, not planting questions but marketing. What we need is a careful, concise and methodical study of this subject from a commercial point of view. It seems to me that what we are now needing most of all is information that will enable us to put our crops into the hands of the consumer at the least possible cost. We are now more and more needing a sort of horticultural political economy.

Horticulture is affected more or less by nearly every science, and by nearly every art. Every walk in life is affected by the agriculture of the country and in turn as we are able to take advantage of the best of everything, will we be able to prosper.

It should be the province of this Society to teach every member of the Association what to grow and how to produce the best of everything. The old adage that, "There's plenty of room at the top," was never more true than it is in horticulture today. The man who markets the best product never has to complain of poor prices. It takes brains to do this, and brains will count whenever they are correctly applied.

During this meeting we are to be favored by a number of eminent persons, both scientific men and practical growers who will present to us addresses and papers during the progress of the meeting, as a glance at the

program will show. I would like to express to these friends of the Society our sincere thanks for their kindness and our appreciation of their valued efforts. After all we have left our homes to come here to learn. We are here not alone for the mere pleasure we get out of the trip, that is a mere incident to the annual pilgrimage, neither are we here that we may accumulate a few more dollars by some sordid method; but we expect to go back home better qualified and better equipped mentally for the unceasing struggle in attempting to do what we are doing, in the right way. We also expect to be better men and women for having met again and visited with our distant friends and neighbors on common ground for argument and discussion.

CITRUS SECTION

CITRUS COVER CROPS

FRED P. LAWRENCE, *Citriculturist*

Florida Agricultural Extension Service
Gainesville

There are so many things I would like to say with regard to citrus cover crops that I hardly know where to begin.

First of all I wish to express my appreciation to Bob Norris, Lake County Agent, Marcel Boudet, Indian River County Agent, and to the growers who have cooperated in establishing demonstrations and allowing us to observe and collect data from them.

I am especially indebted to Bob, for he not only has been instrumental in getting demonstrations set up, but he also has helped do the actual work of measuring, weighing, and collecting the few data we have.

When a large number of citrus groves are examined, it will be found that the groves which have made the best growth and look the best are the ones that have received the most careful attention. Usually these groves are the ones in which cover crops have been grown almost continuously. Why is this?

The changes that are constantly taking place in the soil may be grouped as physical, chemical, and biological. The first relates to movement of water. The second, includes changes brought about by the decomposition of organic matter. The third, or biological change is that caused by soil microorganisms. All three changes, whether physical, chemical or biological, are immediately associated with the presence of organic matter in the soil.

Soil organic matter or humus may be supplied through the purchase of such organic plant foods as dried blood, castor pomace, tankage, and bone meal. These are good materials, but the available supply has been limited in some cases and the cost is always high. Florida growers today are in no position to use high-priced materials if lower-priced ones will do the job equally as well—or even nearly as well. Low-cost organic matter is obtainable in groves simply by the use of an adequate system of cover crop production.

We know from years of research and practical experience that cover crops are valuable in soil management. We have come to the conclusion that the organic matter added by cover crops is valuable because: (1) It increases the base exchange capacity of the soil; (2) It increases the water-holding capacity of the soil; (3) It improves the tilth; (4) It retards erosion; (5) It stimulates beneficial gacterial life; (6) It helps to maintain a high humidity and to moderate the temperature; (7) It helps to conserve natural and applied fertilizers; and (8) It adds nitrogen to the soil if a legume cover crop is used.

Florida's sandy soils are especially in need of organic matter to enable them to withstand our relatively high temperatures and heavy rainfall and to continue productive.

Florida growers long have been wise to these facts and have altered their cultural practices many times in the past 50 years, especially in recent years.

For many years before the depression of the early Thirties, Florida growers had tried various cover crops in citrus groves. Many went so far as mow the road sides and to haul the hay to their groves for mulching but the cost and fire hazards proved too great.

About 1930 Crotalaria striata became very popular as a cover crop, and it appeared to be exactly the plant the grower had been seeking. It gave high tonnages of green material that was relatively high in nitrogen. This plant proved very popular; in fact it was instrumental in bringing many young groves through the depression when most growers were forced to materially reduce their fertilizer programs or leave them off altogether. Then Crotalaria spectabilis, a more succulent plant, was introduced and for a while looked very promising. For some reason, however, both of these crotalarias began to fail to re-seed themselves and, too, they provided feed and harborage for pests that also attacked citrus trees—this was before we had the modern pesticides—so by the early '40's we were again almost dependent on grasses and other native plants for a cover crop to furnish our soils with the greatly needed organic matter. This situation existed until comparatively recently.

In 1931 Dr. Fred Hull of the Florida Agricultural Experiment Station discovered a lone plant growing near a coal pile near the experimental plots in Gainesville. He pointed this plant out to Professor G. E. Ritchey who became interested in it so much that he staked it and cared for it until it produced seeds. These seeds were carefully planted. The plant to which I refer is Indigofera hirsuta, commonly known as Hairy Indigo. This process of re-seeding was repeated many times, with the seeds multiplying each year until about 1944, when he had sufficient seeds available to put them on trial with growers. The plant did not "catch on" until the late '40's but at this time it looks extremely promising as a re-seeding leguminous cover crop for citrus groves, and, too, the truck farmer and the cattle rancher appear to have found a friend in indigo. Recently I had the privilege of going on a county tour where we saw indigo growing for the citrus grower, the cattlemen, and the general farmer. One rancher was obtaining pastures as cheaply as I have ever seen. His land was predominantly deep-phase, Lakeland fine sand. He was renting the wooded area to watermelon farmers who cleared it and produced a crop of melons. Following the melons the grower sowed indigo in the middles to utilize the residual fertilizer from the melon crop to give his indigo a good start. Then, during the late summer rains, he was broadcasting Pangola grass in the strips or middles between the indigo so the Pangola could get the nitrogen that was released by the indigo. Incidentally, he found that his cattle was grazing the indigo and putting on very creditable gains while his Pangola grass was getting established.

The plant is highly resistant to root-knot. It is not a desirable host for the pumpkin or stink bug and it gives a comparatively high tonnage of green manure per acre. Yields of slightly over 22 tons green weight per acre have been checked. However, it appears that under average conditions the yield should be from 15 to 20 thousand pounds per acre in young groves. So far, the plant has shown great promise. It re-seeds itself and it requires no inoculation and special fertilization. Its chief drawback in citrus is its late seeding. Usually it is mid-October before satisfactory seed spikes are produced.

In 1943, an early maturing strain of indigo was introduced and although it has not become widely used, it appears to possess about the same characteristics as the late except it produces mature seeds a little earlier than does the late and will probably give a little less green manure tonnage.

Now, let's consider some of the data and grower comments that we have gotten on

indigo as a citrus cover crop. In doing so, I want to point out that these data are the result of field observations on grower demonstration plots.

In 1947, several growers agreed to set up demonstrations to determine the value of indigo versus native cover crops. In 1948 we began to take samples by which we were able to estimate the green weight yield per acre of the crop and also the probable poundage of nitrogen returned to the soil by the crop. The nitrogen figure looked so astounding that many growers decided to vary the poundage of applied nitrogen to see if their trees were actually getting any of this "free" nitrogen. Here are some of the figures and some comments from a few of the interested growers.

Grove A was planted in 1944, 45 and 46. It contains three ages of trees and also three varieties, Hamlin, Valencia, and Temple oranges, all on rough lemon stock. The grove is planted on a rolling phase of Lakeland fine sand.

Indigo was broadcast in the spring of 1947, a good crop was produced, and allowed to go to seed. It volunteered in 1948 and was chopped once in June. The crop was weighed in September and the green weight yield per acre was 15,824 pounds. Figuring the nitrogen content of this amount of material, we found that it returned 93 pounds of nitrogen per acre, or the equivalent of 583 pounds of nitrate of soda per acre. The crop was cut under in late October 1948.

The indigo volunteered again in 1949 and was not cut under. When it was weighed in September we found a green weight yield of 40,000 pounds, with a total nitrogen content of 236 pounds per acre—equivalent to 1416 pounds of nitrate of soda.

The caretaker for this grove reported that the grove received a normal application of fertilizer until 1948, when he cut the total fertilizer applied in half and has continued to apply half the customary amount of fertilizer since that time. He said the grove growth is as good or better than in a nearby grove of the same age that received the normal program but does not have indigo as a cover crop.

Grove B is planted to Hamlin oranges on rough lemon stock, 20 x 30 feet, on Lakeland fine sand. It was planted in 1944.

This grove was first seeded to indigo in 1947. That year the seed crop was combined and sold but sufficient seed was left to give an excellent volunteer stand in 1948. This grove is chopped twice each year. The first chopping is done in the summer when the indigo is about 3 feet high. Then the indigo is chopped under in the fall.

In 1948, the crop was chopped in the summer and yields were taken in September. From this cut-over or second growth the yield was 19,227 pounds green weight— equivalent to 113 pounds of nitrogen per acre.

Essentially the same program was followed in 1949, but this time the green weight yield was 26,550 pounds, or 156 pounds of nitrogen per acre.

The owner of this grove reported that this land was so "thin" when he planted his trees that a 4-wheel drive Jeep could not get about in the grove, but now there is so much organic matter in the soil that he can drive his car almost anywhere in the grove.

He figured the cover crop was returning considerable nitrogen to the soil, so in 1949 he established three rows across the grove with no nitrogen and three rows with only half the customary nitrogen. The balance of the grove is still on a full program. To date he has noted no significant difference in the tree growth and yield in the various plots.

Grove C is planted to Hamlins on rough lemon stock. It was seeded to indigo in 1947 and there was a good volunteer stand in 1948. The second year stand, uncut was 27,905 green weight or 164 pounds nitrate per acre or 1,028 pounds nitrate of soda equivalent.

In 1949, the third year volunteer crop produced 26,250 pounds or 154 pounds of nitrogen per acre.

The crop was not cut under during the summer of 1948, but it was cut in the summer of '49. Thus the data for 1949 represents the yields of the second growth crop.

The owner of this grove is a foreman of a large packing house and he reported that it

has been his experience that the fruit coming from the blocks of his grove that were planted to indigo have constantly had higher solids than those from blocks where there was no indigo. He has checked this for two years. He further reported that there is an insignificant difference between maturity dates, but he feels the indigo plots will pass as quickly each year as the check plots.

Grove D was planted in December 1944 to early and late varieties on sour orange stock. The soil type is Eustis Fine sand.

Hairy Indigo was planted in May, 1946, at the rate of 4 pounds per acre with a cyclone seeder. Three rows were left as a check block.

Indigo has volunteered each spring. The grove was disked for the last time June 10th this year.

Cultural practices are identical throughout the grove except for the check block which has no Indigo. The trees in the check plot were very yellow when yields were measured, on September 15th. The trees having indigo were a deep green and were producing a luxuriant fall flush of new growth. The indigo produced 12,500 pounds of green weight per acre.

In spite of the spring drouth the unirrigated indigo blocks bloomed and set a very uniform crop before the check rows bloomed.

The indigo blocks matured their fruit about 10 days ahead of the check plots. And here's a summary of maturity tests run and comments of the tester:

	Hairy indigo	Check
Acids	.79	.79
Total Solids	9.31	9.24
Ratio	11.81	11.50

"The test was taken September 15, 1949. The oranges planted in indigo are greener in color, rougher skinned, not ricey inside and are sweet in taste. The oranges in the check rows are lighter in color, smoother skinned, are a little ricey inside and are not as sweet and have a decided bitter taste. An average of juice content shows the oranges at size 250 in the indigo to have 25% more juice than those of the same size in the check rows. The trees in the indigo are approximately a year advanced in size and are much greener in color."

Similar data from several other groves are available but I will not go into them now. From the data we have and observations, we who have worked with it and observed it believe hairy indigo is certainly the friend of the grower seeking lower production cost. It is adapted for use in bringing young groves into production, because of the large amount of nitrogen it adds to the soil. For the same reason, it should be valuable in old groves, where conditions permit its growth.

Here is some data taken from a 25 year old grove. The variety is connor's seedless orange on rough lemon rootstock. The soil type is Lakeland fine sand. The trees are spaced 25' x 30'.

For the past fifteen years the grove has received nitrogen and potash as a fertilizer, no phosphate. The minor or secondary elements have been made in the fertilizer applications. Dolomite has been used to keep the pH up.

The yield data for the past five years are as follows:

1945 — 6,503	1948 — 5,185
1946 — 7,878	1949 — 19,800
1947 — 11,255	1950 — Est. 20,000

This grove had Alice Clover in 1948 and indigo as a cover crop in 1949. The cultural practice has remained constant since 1946 with the exception of the cover crop.

Now I am not giving you this data and telling you that a legume cover is totally responsible for this large jump in production. No doubt it did help. The point I wish to bring out is that indigo will grow sufficiently well to be of considerable value in some of the older groves. Incidentally, I have a series of color slides of these groves I hope to show you if I can do so in my alloted time.

Most citrus experts will agree that it takes from 90 to 120 pounds of nitrogen per acre to produce a 400-box crop. It appears that hairy indigo will produce an average crop of 15,000 pounds green weight per acre per year. This will yield about 90 pounds of nitrogen per acre—when figured on the basis of a solid acre. So assuming, because of our cultural practices, that the crop actually covers only

half of the acre area, we have a nitrogen yield of 45 pounds per acre from our cover crop, which is from one-third to one-half of the total nitrogen required to produce the crop.

Summing up, then:

Indigo is highly resistant to root-knot.

It appears that indigo is not a preferred host plant of pumpkin bugs.

Indigo should be seeded in the spring at the rate of 4 to 8 pounds per acre, depending on the method used.

Indigo does not require inoculation nor special fertilization when sown in citrus groves.

Indigo gives comparatively high yields of green weight per acre.

It appears from the limited amount of available information that indigo does not delay maturity in citrus.

Citrus grown in indigo cover crop appears to have higher solids and juice content.

Although large amounts of nitrogen appears to be released by indigo, current indications are that applications of fertilizer nitrogen will be necessary at certain seasons of the year.

Hairy indigo is still a comparatively new crop and there is a great deal to be learned about its effect on the soil and on the various varieties of citrus. So far, it looks mighty promising.

BOXES HARVESTED, COSTS AND RETURNS ON ORANGE AND GRAPEFRUIT GROVES FOR 17 SEASONS, 1931-48

ZACH SAVAGE

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The cooperation of interested growers made possible a study of citrus costs and returns by the Florida Agricultural Extension Service. This study began in 1931 and is still in progress. An average of 252 groves has been included each season for the past 17 seasons, 1931-48. Of the groves over 10 years of age, there was an average of 41 per season in which 90 percent or more of the trees were orange. On the same basis there was an average of 9 that were grapefruit groves. It was from these orange and grapefruit grove records that the contents of this paper were derived. The sample of grapefruit groves is small but records of such are difficult to obtain since there is such a small proportion of groves that are grapefruit groves.

These groves were scattered over the citrus-producing area of Florida. However, averages of data from these groves are by no means taken to represent averages for the entire citrus-producing area of the state. There was no process of selection to locate or select these groves. Records were obtained from any and all growers who would supply copies. It is believed that the average grove of these records was better than the average for all groves of its kind within the state. Consequently, average data from these groves are expected to show more favorable results than comparable data for all groves of like kind within Florida. However, it is believed that trends in the averages for these groves are similar to the trends in averages of all groves of like kind.

Age of tree from time of setting in the grove is the easiest and most convenient method of delineating groves when comparing yields, costs, and returns. Many groves included in this study had trees of varying ages. In such cases the average age was used. This average was weighted by the number of trees of each age. It is important to consider age when making comparisons. The average age per season increased somewhat as this period progressed for orange and grapefruit groves.

Boxes harvested per acre increased materially as the period progressed on both oranges and grapefruit groves (Chart 1 and Table1).

The three 5-year averages of yield for the first 15 years of this period indicate this increase rather vividly (Tables 9 and 10). Orange yields increased 52 percent in the second 5-year period over the first, and 109 percent in the third period. Grapefruit yields increased 49 and 65 percent, respectively, for the same periods. Increases in ages contributed to these increases. Also better fertilizer practices, larger proportions of fruit harvested, and increased proportions of acreage irrigated were other factors contributing to these increases. Fruit prices were low during some seasons of the first two 5-year periods, which resulted in some of the fruit remaining unharvested. Less damage from low temperatures and better grove care in general during the last two periods contributed to higher yields for these periods; and higher prices, together with the development of fruit processing facilities, contributed to higher proportions of the fruit being harvested.

Storms, hurricanes, drouths, and low temperatures reduced the number of boxes harvested during some seasons (Chart 1). Strong winds affected grapefruit yields more than orange during the latter part of the fruit season, due to the larger size of fruit. These and other factors resulted in wide fluctuations in yields of orange and grapefruit groves, particularly grapefruit.

Table 1.—AGE OF TREES AND BOXES HARVESTED ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES		GRAPEFRUIT GROVES	
Season	Age	Boxes Harvested Per Acre	Age	Boxes Harvested Per Acre
1931-32	18	139	15	269
1932-33	20	148	16	228
1933-34	19	112	19	144
1934-35	19	143	19	339
1935-36	18	158	19	134
1936-37	18	169	21	330
1937-38	20	197	20	249
1938-39	20	247	20	381
1939-40	21	223	20	266
1940-41	21	227	20	441
1941-42	22	234	20	429
1942-43	22	287	21	321
1943-44	22	332	22	354
1944-45	21	267	22	275
1945-46	22	347	23	456
1946-47	23	329	24	367
1947-48	24	346	27	463
17-Yr. Avg.	21	230	20	320

Orange yields averaged less than 200 boxes per acre annually during the first 7 seasons and were above that figure each season since. Orange yields were higher than 325 boxes in 4 of the last 5 seasons. Grapefruit yields were less than 150 boxes for 2 seasons and higher than 425 boxes for 4 seasons. The average for the 17 seasons was 230 for orange, and 320 boxes per acre, or 39 percent higher, for grapefruit. There was one season, 1935-36, when the number of boxes harvested per acre was less for grapefruit than oranges.

Labor, power, and equipment costs were higher than any other item for orange groves during the 17 seasons. This item was second to fertilizer materials for grapefruit groves. This cost doubled on both orange and grapefruit groves on a per-acre basis during the last 5 seasons of this period (Table 2 and Chart 2). Increases in yields on orange groves as the period progressed resulted in this cost remaining at 20 cents per box or lower except the last 2 seasons, when it rose to 27 and 28 cents. The season when this cost was lowest for oranges was 1938-39, when the cost was 12 cents per box, and 1934-35 was lowest at $19.07 on the per-acre basis.

This cost averaged 12 percent higher on grapefruit on the per-acre basis than on orange groves, but only 78 percent as much on the per-box basis. The season with the lowest cost per acre for labor, power, and equipment was 1939-40, when it was $22.61. The season of highest cost per acre for this item for both orange and grapefruit groves was 1947-48. There were 2 seasons when such costs were 8 cents per box on grapefruit groves while the highest cost was 25 cents in 1946-47.

Fertilizer material costs per acre more than doubled during this period on orange groves. The increase was not so great on grapefruit groves. The low fertilizer cost season for orange groves was 1933-34, when it was $21.98 per acre, and the high was 1946-47 at $63.63 per acre (Table 3 and Chart 3). The low per-box figure for this item was 11 cents and such costs stood at this figure for 3 successive seasons, 1939-42. The high figure was 23 cents per box for oranges in 1934-35. The low per-acre fertilizer cost for grapefruit was $31.15 in 1940-41 and the high was

$80.75 in 1947-48. The low per-box figure for grapefruit was 7 cents in 1940-41, with the high of 29 cents in 1935-36. The 17-year average fertilizer cost per acre was $36.24 for oranges and $50.89 for grapefruit, or 40 percent higher for grapefruit. The period average was the same for oranges and grapefruit on a per-box basis, and was 16 cents. The cost of fertilizer materials per acre averaged 38 percent of the operating costs on orange groves and 43 percent on grapefruit.

Spray and dust materials costs were 7 percent of the average operating cost per acre on orange groves and 9 percent on grapefruit groves. This cost was $6.86 per acre on orange groves and $10.46, or 52 percent higher on grapefruit. Grapefruit trees are usually larger in size and require more spray or dust for complete coverage.

TABLE 2.
AGE OF TREES AND COST OF LABOR, POWER, AND EQUIPMENT ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES Labor, Power, & Equipment Costs			GRAPEFRUIT GROVES Labor, Power & Equipment Costs		
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$20.62	$.15	15	$ 37.39	$.14
1932-33	20	24.70	.17	16	46.27	.20
1933-34	19	23.22	.21	19	33.32	.23
1934-35	19	19.07	.14	19	25.36	.08
1935-36	18	23.43	.15	19	30.95	.23
1936-37	18	24.66	.15	21	36.51	.08
1937-38	20	25.68	.13	20	29.82	.12
1938-39	20	29.66	.12	20	40.55	.10
1939-40	21	31.60	.15	20	22.61	.09
1940-41	21	37.55	.17	20	40.53	.09
1941-42	22	39.13	.17	20	45.17	.10
1942-43	22	41.74	.14	21	29.90	.09
1943-44	22	48.33	.14	22	46.56	.13
1944-45	21	52.61	.20	22	47.60	.18
1945-46	22	67.83	.20	23	66.18	.15
1946-47	23	87.43	.27	24	93.04	.25
1947-48	24	96.09	.28	27	102.56	.22
17-Yr. Avg.	21	40.79	.18	20	45.55	.14

TABLE 3.
AGE OF TREES AND COST OF FERTILIZER MATERIALS ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES Fertilizer Mtls.			GRAPEFRUIT GROVES Fertilizer Mtls.		
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$29.45	$.21	15	$ 66.83	$.24
1932-33	20	27.69	.18	16	49.11	.22
1933-34	19	21.98	.20	19	33.48	.23
1934-35	19	32.69	.23	19	39.28	.12
1935-36	18	24.51	.16	19	38.23	.29
1936-37	18	26.02	.15	21	43.11	.09
1937-38	20	33.32	.17	20	54.73	.23
1938-39	20	31.50	.13	20	46.11	.12
1939-40	21	24.25	.11	20	32.09	.12
1940-41	21	25.65	.11	20	31.15	.07
1941-42	22	24.30	.11	20	34.76	.08
1942-43	22	39.90	.13	21	44.58	.14
1943-44	22	46.21	.14	22	52.96	.15
1944-45	21	51.19	.19	22	68.82	.25
1945-46	22	52.77	.15	23	70.22	.15
1946-47	23	63.63	.19	24	78.84	.21
1947-48	24	61.02	.18	27	80.75	.17
17-Yr. Avg.	21	36.24	.16	20	50.89	.16

TABLE 4.
AGE OF TREES AND COST OF SPRAY AND DUST MATERIALS ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES Spray & Dust Mtls.			GRAPEFRUIT GROVES Spray & Dust Mtls.		
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$ 2.57	$.02	15	$ 8.34	$.03
1932-33	20	3.87	.03	16	9.57	.04
1933-34	19	3.65	.03	19	12.41	.09
1934-35	19	4.13	.03	19	7.67	.02
1935-36	18	3.57	.02	19	6.49	.05
1936-37	18	4.44	.02	21	8.46	.02
1937-38	20	6.27	.03	20	8.46	.03
1938-39	20	5.71	.02	20	11.15	.03
1939-40	21	5.55	.02	20	6.22	.02
1940-41	21	6.25	.03	20	8.89	.02
1941-42	22	7.30	.03	20	9.42	.02
1942-43	22	10.16	.04	21	11.45	.04
1943-44	22	9.71	.03	22	11.41	.03
1944-45	21	10.22	.04	22	11.86	.04
1945-46	22	10.22	.03	23	12.25	.03
1946-47	23	11.16	.03	24	20.21	.06
1947-48	24	11.88	.03	27	13.60	.03
17-Yr. Avg.	21	6.86	.03	20	10.46	.03

TABLE 5.
AGE OF TREES AND OPERATING COSTS ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

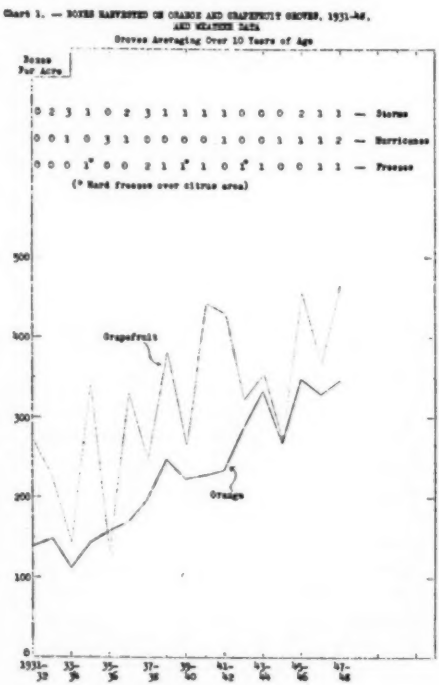
	ORANGE GROVES Operating Costs			GRAPEFRUIT GROVES Operating Costs		
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$ 65.26	$.47	15	$125.81	$.46
1932-33	20	64.99	.44	16	114.42	.50
1933-34	19	55.54	.50	19	88.49	.61
1934-35	19	61.25	.43	19	80.75	.24
1935-36	18	67.65	.43	19	94.31	.71
1936-37	18	66.66	.39	21	101.01	.22
1937-38	20	75.72	.38	20	104.93	.42
1938-39	20	78.41	.32	20	178.78	.30
1939-40	21	74.65	.34	20	72.27	.27
1940-41	21	83.12	.37	20	90.50	.20
1941-42	22	79.63	.34	20	96.68	.22
1942-43	22	104.85	.36	21	94.17	.30
1943-44	22	118.23	.36	22	121.04	.34
1944-45	21	127.46	.48	22	137.40	.50
1945-46	22	145.32	.42	23	157.63	.35
1946-47	23	178.67	.54	24	201.72	.55
1947-48	24	193.23	.56	27	218.05	.47
17-Yr. Avg.	21	96.51	.42	20	118.41	.37

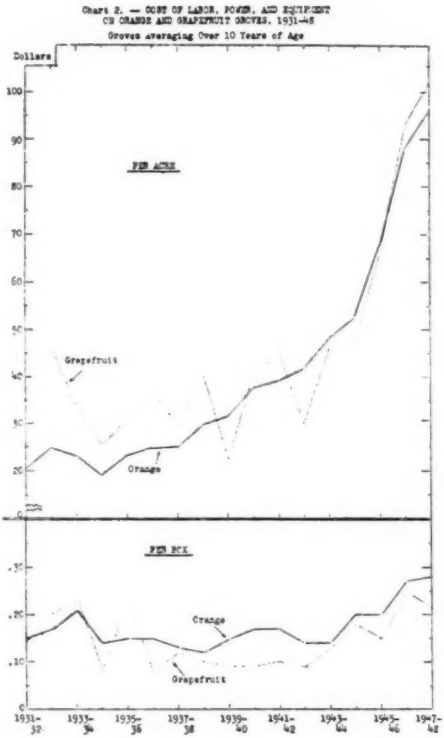
Spray and dust materials costs more than tripled on orange groves during the period on an acre basis (Table 4 and Chart 4). The increase per box was not so great. Also the increase in the cost on grapefruit groves was less than on orange groves.

Operating costs per acre averaged $96.51 on orange and $118.41, or 23 percent more, on grapefruit groves (Table 5). The lowest season figure was $55.54 in 1933-34 for orange groves, and the highest was $193.23 in 1947-

48 (Chart 5). The per-box variation for oranges was from 32 cents in 1938-39 to 56 cents in 1947-48. The low operating cost figure for grapefruit groves was $72.27 per acre in 1939-40 and the high was $218.05 in 1947-48. The per-box figures for these costs ranged from 20 cents in 1940-41 to 71 cents in 1935-36. The average for the 17 seasons was 37 cents per box for grapefruit and 42 cents, or 14 percent higher, for oranges. There were 2 seasons, 1939-40 and 1942-43, when operating costs per acre were higher on orange than on grapefruit groves.

Returns from fruit per box by seasons were consistently higher on orange than on grapefruit groves, and averaged 105 percent higher (Chart 6). The range in the increase of orange prices over grapefruit was from 13 percent more in 1937-38 to 289 percent more in 1936-37. The average price received per box for the 17 seasons was $1.25 for oranges and 61 cents for grapefruit (Table 6). The range in seasonal prices for oranges was from 54 cents in 1947-48 to $2.47 in 1945-46, and the range for grapefruit was from 20 cents in 1938-39 to $1.39 in 1944-45.



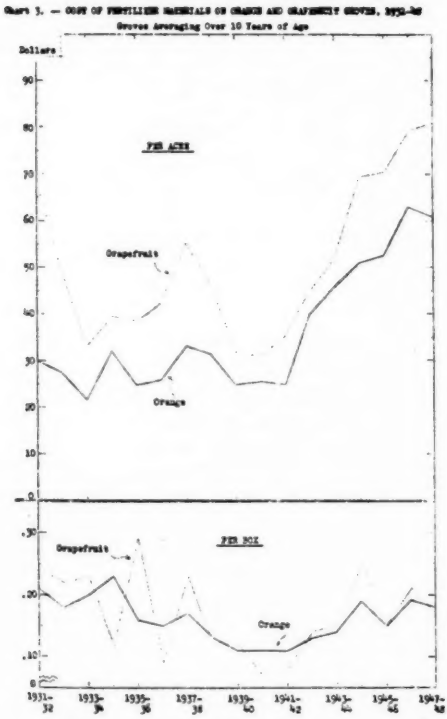


Returns from fruit per acre are determined by the price of fruit and the fruit harvested. Hence the low and high seasons were not the same seasons on both the per-acre and per-box basis, except that the high per-box and per-acre figures for oranges occurred in the same season, 1945-46, when returns per acre averaged $858.00. This season was also the highest in number of boxes of fruit harvested. The low season for oranges was 1932-33, when the figure was $83.50 per acre. The low season for grapefruit returns was 1932-33, when it was $73.53 per acre, and the high was $491.14 in 1945-46. The highest returns per acre occurred in the same season, 1945-46,

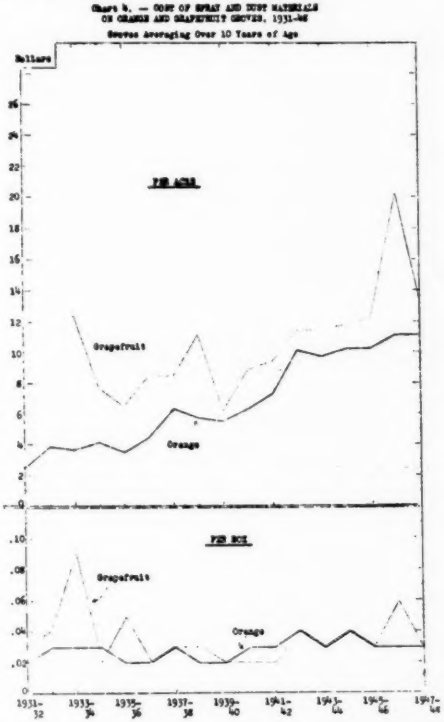
when the orange figure was 75 percent higher than that for grapefruit.

TABLE 6.
AGE OF TREES AND RETURNS FROM FRUIT ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES			GRAPEFRUIT GROVES		
		Returns from Fruit			Returns from Fruit	
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$179.28	$1.29	15	$127.32	3.47
1932-33	20	83.50	.57	16	73.53	.32
1933-34	19	99.97	.90	19	96.51	.67
1934-35	19	110.79	.78	19	75.02	.22
1935-36	18	196.39	1.24	19	73.94	.56
1936-37	18	250.50	1.48	21	175.79	.38
1937-38	20	116.69	.59	20	130.06	.52
1938-39	20	135.78	.55	20	74.75	.20
1939-40	21	139.82	.63	20	117.51	.44
1940-41	21	173.94	.77	20	147.86	.33
1941-42	22	273.11	1.17	20	347.67	.81
1942-43	22	528.90	1.84	21	292.63	.91
1943-44	22	621.55	1.88	22	418.07	1.18
1944-45	21	626.61	2.35	22	383.10	1.39
1945-46	22	858.00	2.47	23	491.14	1.08
1946-47	23	300.09	.91	24	204.38	.56
1947-48	24	185.21	.54	27	103.90	.22
17-Yr. Avg.	21	287.06	1.25	20	196.07	.61



Average returns from fruit per acre for oranges, $287.06, were 46 percent more than for grapefruit, $196.07. There were 2 seasons, 1937-38 and 1941-42, when returns per acre from fruit were higher from grapefruit than from oranges.



Returns above operating costs were higher per acre each season on orange groves except in 1941-42 (Chart 7). The average for the 17 seasons was $77.66 for grapefruit and $190.55, or 145 percent higher, on oranges (Table 7). Oranges returned operating costs each season except in 1947-48. Grapefruit failed to return operating costs during 5 of the 17 seasons. The season of highest returns above operating costs per acre for both oranges and grapefruit was 1945-46, when the figures were $712.68 and $333.51, respectively. This same season was the highest on a per-box basis, $2.05, for oranges, while the previous season, 1944-45, was highest for grapefruit, when it was 89 cents. The average for all seasons was 83 cents per box for oranges

and 24 cents for grapefruit. Returns above operating costs were higher each season on a per-box basis on oranges, and averaged 246 percent higher.

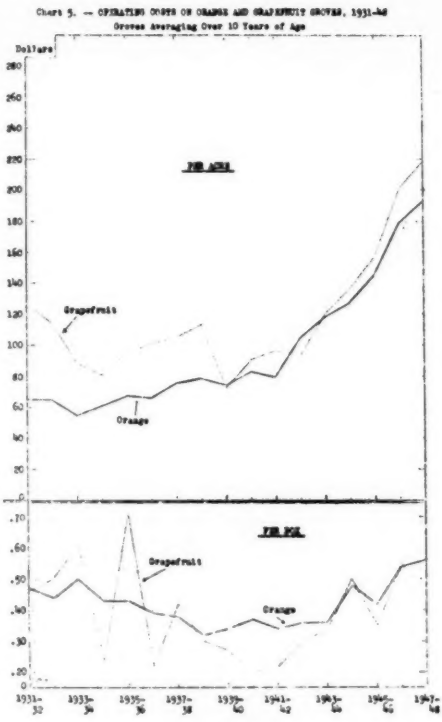
In the 1947-48 season, 44 percent of the orange groves failed to return operating costs, and 89 percent of the grapefruit failed likewise (Table 8). In the 1946-47 season, 14 percent of the orange and 58 percent of the grapefruit groves failed to return operating costs. All orange and grapefruit groves returned operating costs in 1945-46. On the average for the 17 seasons, 17 percent of the orange groves and 33 percent of the grapefruit groves failed to pay operating costs.

TABLE 7.
AGE OF TREES AND RETURNS ABOVE OPERATING COSTS ON ORANGE AND GRAPEFRUIT GROVES, 1931-48

	ORANGE GROVES Returns Above Operating Costs			GRAPEFRUIT GROVES Returns Above Operating Costs		
Season	Age	Per Acre	Per Box	Age	Per Acre	Per Box
1931-32	18	$114.02	$.82	15	$ 1.51	$.01
1932-33	20	18.51	.13	16	—40.89	—.18
1933-34	19	44.43	.40	19	8.02	.06
1934-35	19	49.54	.35	19	—5.73	—.02
1935-36	18	128.74	.81	19	—20.37	—.15
1936-37	18	183.84	1.09	21	74.78	.16
1937-38	20	40.97	.21	20	25.13	.10
1938-39	20	57.37	.23	20	—39.03	—.10
1939-40	21	65.17	.29	20	45.24	.17
1940-41	21	90.82	.40	20	57.36	.13
1941-42	22	193.48	.83	20	250.99	.59
1942-43	22	424.05	1.48	21	198.46	.61
1943-44	22	503.32	1.52	22	297.03	.84
1944-45	21	499.15	1.87	22	245.70	.89
1945-46	22	712.68	2.05	23	333.51	.73
1946-47	23	121.42	.37	24	2.66	.01
1947-48	24	—8.02	—.02	27	—114.15	—.25
17-Yr. Avg.	21	190.55	.83	20	77.66	.24

TABLE 8.
PERCENT OF GROVES THAT FAILED TO RETURN OPERATING COSTS

Season	Orange	Grapefruit
1931-32	0	40
1932-33	50	100
1933-34	13	50
1934-35	39	62
1935-36	16	89
1936-37	2	0
1937-38	39	56
1938-39	17	75
1939-40	41	22
1940-41	11	10
1941-42	6	0
1942-43	4	9
1943-44	0	0
1944-45	4	18
1945-46	0	0
1946-47	14	58
1947-48	44	89
17-Yr. Avg.	17	33



Summary

The sample of orange groves is larger than grapefruit but very likely the grapefruit sample is proportionately as large as the sample of orange groves, since there are so few grapefruit groves in Florida.

The averages from these samples may differ from the average of all similar groves but the trends should be similar to that for all like groves.

The average age of orange groves does not vary widely from season to season from that of grapefruit groves.

Boxes harvested per acre from grapefruit groves averaged 39 percent higher than from orange groves.

The per-acre cost of labor, power, and equipment averaged 12 percent higher on grapefruit groves and 78 percent as much on the per-box basis.

Money spent for fertilizer materials averaged 40 percent higher for grapefruit on the per-acre basis and was the same per box.

Spray and dust material costs were 52 percent higher per acre on grapefruit and were the same per box.

Operating costs per acre were 23 percent higher on grapefruit and 12 percent less per box.

Returns from fruit per acre were 46 percent higher on orange groves and 105 percent higher per box.

Returns above operating costs per acre were 145 percent higher on oranges and 246 percent higher per box.

In 1932-33 50 percent of orange and 100 percent of grapefruit groves failed to return operating costs.

Chart 6. — RETURNS FROM FRUIT ON ORANGE AND GRAPEFRUIT GROVES, 1931-48
Groves Averaging Over 10 Years of Age

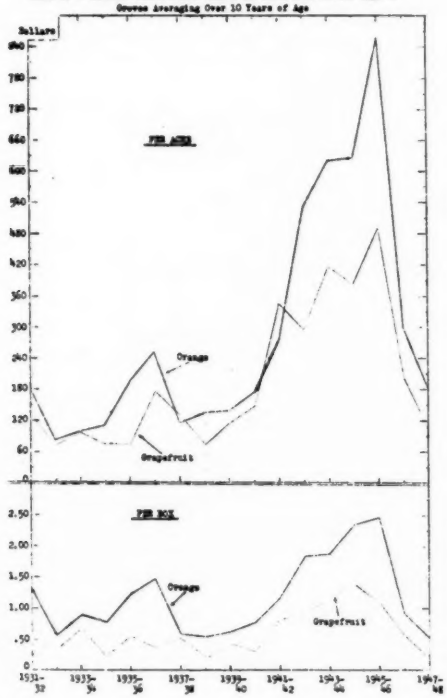
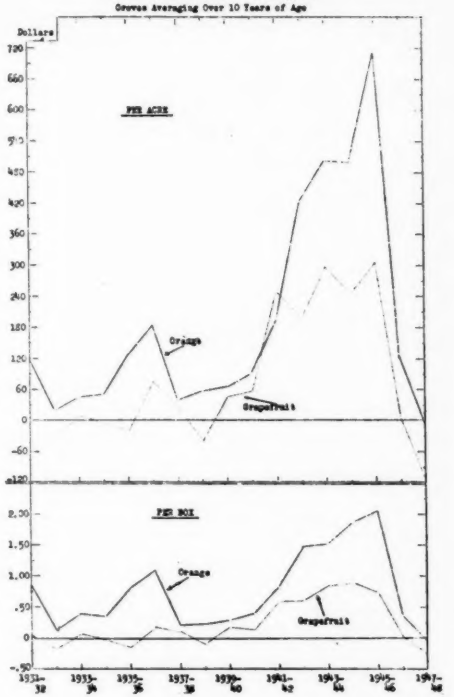


Chart 7. — RETURNS ABOVE OPERATING COSTS ON ORANGE AND GRAPEFRUIT GROVES, 1931-48
Groves Averaging Over 10 Years of Age



The season of 1947-48 was the only season when returns from all orange groves failed to return operating costs.

There were 5 of the 17 seasons when returns from all grapefruit groves failed to pay operating costs, and the loss was greatest in 1947-48.

There were 3 seasons when each orange grove returned its operating costs. There were 4 seasons when each grapefruit grove returned its operating costs.

There were 5 seasons when in excess of 33 percent of the orange groves failed to return operating costs. Similarly, there were 9 seasons when in excess of 33 percent of the grapefruit groves failed in this regard.

Over the 17-year period 1 out of 6 orange groves failed to return operating costs, and 1 out of 3 grapefruit groves failed also.

ORANGE GROVES

Table 9. — SUMMARY OF COSTS AND RETURNS PER ACRE AND PER BOX - GROVES AVERAGING OVER 10 YEARS OF AGE HAVING 90% OR MORE ORANGE TREES

	1931-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43	1943-44	1944-45	1945-46
Number of grove records	9	22	38	28	38	47	49	41	46	47	47	46	47	52	48
Total acres of records	160.3	346.3	614.0	361.4	511.9	680.4	874.9	774.1	796.5	1086.4	1047.8	992.3	1060.3	1132.5	1157.0
Average acres per grove	18	16	16	13	13	14	18	19	17	23	22	22	23	22	24
Average age	18	20	19	19	18	18	20	20	21	21	22	22	22	21	22
Number of trees per acre	62	60	62	64	65	65	66	63	63	66	67	68	66	67	67
Percent trees ORANGE	97.9	98.2	96.5	98.7	99.2	98.3	97.9	98.0	97.8	96.4	96.9	96.9	96.8	97.4	97.3
Boxes harvested per acre	139	148	112	143	158	169	197	247	223	227	234	287	332	267	347
Costs per acre:															
Labor, power, and equipment	$ 20.62	$ 24.70	$ 23.22	$ 19.07	$ 23.43	$ 24.66	$ 25.68	$ 29.66	$ 31.60	$ 37.55	$ 39.13	$ 41.74	$ 48.33	$ 52.61	$ 67.83
Fertilizer materials	29.45	27.69	21.98	32.69	24.51	26.02	33.32	31.50	24.25	25.65	24.30	39.90	46.21	51.19	52.77
Spray and dust materials	2.57	3.87	3.65	4.13	3.57	4.44	6.27	5.71	5.55	6.25	7.30	10.16	9.71	10.22	10.22
State and county taxes	11.66	7.76	6.03	4.68	6.90	5.56	6.44	6.47	6.89	5.57	5.52	5.13	5.59	5.29	5.99
Miscellaneous	.96	.97	.66	.68	9.24	5.98	4.01	5.07	6.36	8.10	3.38	7.92	8.39	8.15	8.51
Total operating costs	65.26	64.99	55.54	61.25	67.65	66.66	75.72	78.41	74.65	83.12	79.63	104.85	118.23	127.46	145.32
Interest on grove valuation @ 6%	46.47	58.87	42.71	42.60	43.10	42.14	40.45	37.83	37.96	33.73	33.70	31.33	31.56	36.88	36.31
Total cost without owner supervision	111.73	123.86	98.25	103.85	110.75	108.80	116.17	116.24	112.61	116.85	113.33	136.18	149.79	164.34	181.63
Returns per acre:															
Returns from fruit	179.28	83.50	99.97	110.79	196.39	250.50	116.69	135.78	139.82	173.94	273.11	528.90	621.55	626.61	858.00
Net returns	67.55	-40.36	1.72	6.94	85.64	141.70	.52	19.54	27.21	57.09	159.78	392.72	471.76	462.27	676.37
Returns above operating costs	114.02	18.51	44.43	49.54	128.74	183.84	40.97	57.37	65.17	90.82	193.48	424.05	503.32	499.15	712.68
Costs per box:															
Labor, power, and equipment	.15	.17	.21	.14	.15	.15	.13	.12	.15	.17	.17	.14	.14	.20	.20
Fertilizer materials	.21	.18	.20	.23	.16	.15	.17	.13	.11	.11	.11	.13	.14	.19	.15
Spray and dust materials	.02	.03	.03	.03	.02	.02	.03	.02	.02	.03	.03	.04	.03	.04	.03
State and county taxes	.08	.05	.05	.03	.04	.03	.03	.03	.03	.02	.02	.02	.02	.02	.02
Miscellaneous	.01	.01	.01	*	.06	.04	.02	.02	.03	.04	.01	.03	.03	.03	.02
Total operating costs	.47	.44	.50	.43	.43	.39	.38	.32	.34	.37	.34	.36	.36	.48	.42
Interest on grove valuation @ 6%	.34	.40	.38	.30	.27	.25	.21	.15	.17	.15	.14	.11	.10	.14	.10
Total cost without owner supervision	.81	.84	.88	.73	.70	.64	.59	.47	.51	.52	.48	.47	.46	.62	.52
Returns per box:															
Returns from fruit	1.29	.57	.90	.78	1.24	1.48	.59	.55	.63	.77	1.17	1.84	1.88	2.35	2.47
Net returns	.48	-.27	.02	.05	.54	.84	*	.08	.12	.25	.69	1.37	1.42	1.73	1.95
Returns above operating costs	.82	.13	.40	.35	.81	1.09	.21	.23	.29	.40	.83	1.48	1.52	1.87	2.05

	1946-47	1947-48	17-Year Average 1931-48	5-Year Averages 1931-36	1936-41	1941-46
Number of grove records, or average	49	48	41	27	46	48
Total acres of records, or average	1254.5	1261.7	830.2	398.8	842.5	1078.0
Average acres per grove	26	26	20	15	18	23
Average age	23	24	21	19	20	22
Number of trees per acre	68	67	65	63	65	67
Percent trees ORANGE	97.1	96.7	97.5	98.1	97.7	97.1
Boxes harvested per acre	329	346	230	140	213	293
Costs per acre:						
Labor, power, and equipment	$ 87.43	$ 96.09	$ 40.79	$ 22.21	$ 29.83	$ 49.93
Fertilizer materials	63.63	61.02	36.24	27.26	28.15	42.87
Spray and dust materials	11.16	11.88	6.86	3.56	5.64	9.52
State and county taxes	6.89	9.95	6.61	7.41	6.19	5.51
Miscellaneous	9.56	14.29	6.01	2.50	5.90	7.27
Total operating costs	178.67	193.23	96.51	62.94	75.71	115.10
Interest on grove valuation @ 6%	40.95	43.17	39.98	46.75	38.42	33.95
Total cost without owner supervision	219.62	236.40	136.49	109.69	114.13	149.05
Returns per acre:						
Returns from fruit	300.09	185.21	287.06	133.99	163.34	581.63
Net returns	80.47	-51.19	150.57	24.30	49.21	432.58
Returns above operating costs	121.42	-8.02	190.55	71.05	87.63	466.53

	1946-47	1947-48	17-yr. Avg. 1931-1948	5 yr. Average: 1931-1936	1936-1941	1941-1946
Costs per box:						
Labor, power, and equipment	.27	.28	.18	.16	.14	.17
Fertilizer materials	.19	.18	.16	.19	.13	.15
Spray and dust materials	.03	.03	.03	.03	.03	.03
State and county taxes	.02	.03	.03	.05	.03	.02
Miscellaneous	.03	.04	.02	.02	.03	.02
Total operating costs	.54	.56	.42	.45	.36	.39
Interest on grove valuation @ 6%	.13	.12	.17	.33	.18	.12
Total cost without owner supervision	.67	.68	.59	.78	.54	.51
Returns per box:						
Returns from fruit	.91	.54	1.25	.96	.77	1.98
Net returns	.24	-.14	.66	.18	.23	1.47
Returns above operating costs	.37	-.02	.83	.51	.41	1.59

* Less than $0.005

GRAPEFRUIT GROVES

Table 10. — SUMMARY OF COSTS AND RETURNS PER ACRE AND PER BOX - GROVES AVERAGING OVER 10 YEARS OF AGE HAVING 90% OR MORE GRAPEFRUIT TREES

	1931-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43	1943-44	1944-45	1945-46
Number of grove records	5	6	6	8	9	8	9	8	9	10	11	11	10	11	11

GRAPEFRUIT GROVES

Table 10. — SUMMARY OF COSTS AND RETURNS PER ACRE AND PER BOX - GROVES AVERAGING OVER 10 YEARS OF AGE HAVING 90% OR MORE GRAPEFRUIT TREES

	1931-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43	1943-44	1944-45	1945-46
Number of grove records	5	6	6	8	9	8	9	8	9	10	11	11	10	11	11
Total acres of records	30.9	45.9	45.9	67.9	77.9	67.9	82.9	77.0	89.0	97.1	106.1	184.0	174.0	189.0	188.0
Average acres per grove	6	8	8	8	9	8	9	10	10	10	10	17	17	17	17
Average age	15	16	19	19	19	21	20	20	20	20	20	21	22	22	23
Number trees per acre	62	63	63	62	62	62	69	68	69	62	68	60	60	61	61
Percent trees GRAPEFRUIT	100	100	100	99.2	98.4	99.2	99.1	98.7	98.2	98.6	98.4	99.0	98.9	98.6	98.6
Boxes harvested per acre	269	228	144	339	134	330	249	381	266	441	429	321	354	275	456
Costs per acre:															
Labor, power, and equipment	$ 37.39	$ 46.27	$ 33.32	$ 25.36	$ 30.95	$ 36.51	$ 29.82	$ 40.55	$ 22.61	$ 40.53	$ 45.17	$ 29.90	$ 46.56	$ 47.60	$ 66.18
Fertilizer materials	66.83	49.11	33.48	39.28	38.23	43.11	54.73	46.11	32.09	31.15	34.76	44.58	52.96	68.82	70.22
Spray and dust materials	8.34	9.57	12.41	7.67	6.49	8.46	8.46	11.15	6.22	8.89	9.42	11.45	11.41	11.86	12.25
State and county taxes	11.71	8.71	9.14	8.33	10.89	8.69	8.62	6.02	4.76	5.76	7.22	5.15	5.52	5.43	5.98
Miscellaneous	1.54	.76	.14	.11	7.75	4.24	3.30	9.95	6.59	4.17	.11	3.09	4.59	3.69	3.00
Total operating costs	125.81	114.42	88.49	80.75	94.31	101.01	104.93	113.78	72.27	90.50	96.68	94.17	121.04	137.40	157.63
Interest on grove valuation @ 6%	28.99	29.00	39.87	28.26	26.65	28.14	24.54	21.58	23.06	25.46	25.00	18.32	18.00	18.43	20.81
Total cost without owner supervision	154.80	143.42	128.36	109.01	120.96	129.15	129.47	135.36	95.33	115.96	121.68	112.49	139.04	155.83	178.44
Returns per acre:															
Returns from fruit	127.32	73.53	96.51	75.02	73.94	175.79	130.06	74.75	117.51	147.86	347.67	292.63	418.07	383.10	491.14
Net returns	-27.48	-69.89	-31.85	-33.99	-47.02	46.64	.59	-60.61	22.18	31.90	225.99	180.14	279.03	227.27	312.70
Returns above operating costs	1.51	-40.89	8.02	-5.73	-20.37	74.78	25.13	-39.03	45.24	57.36	250.99	198.46	297.03	245.70	333.51
Costs per box:															
Labor, power, and equipment	.14	.20	.23	.08	.23	.08	.12	.10	.09	.09	.10	.09	.13	.18	.15
Fertilizer materials	.24	.22	.23	.12	.29	.09	.23	.12	.12	.07	.08	.14	.15	.25	.15
Spray and dust materials	.03	.04	.09	.02	.05	.02	.03	.03	.02	.02	.02	.04	.03	.04	.03
State and county taxes	.04	.04	.06	.02	.08	.02	.03	.02	.02	.01	.02	.02	.02	.02	.01
Miscellaneous	.01	*	*	*	.06	.01	.01	.03	.02	.01	*	.01	.01	.01	.01
Total operating costs	.46	.50	.61	.24	.71	.22	.42	.30	.27	.20	.22	.30	.34	.50	.35
Interest on grove valuation @ 6%	.11	.13	.28	.08	.20	.06	.10	.06	.09	.06	.06	.05	.05	.07	.04
Total cost without owner supervision	.57	.63	.89	.32	.91	.28	.52	.36	.36	.26	.28	.35	.39	.57	.39
Returns per box:															
Returns from fruit	.47	.32	.67	.22	.56	.38	.52	.20	.44	.33	.81	.91	1.18	1.39	1.08
Net returns	-.10	-.31	-.22	-.10	-.35	.10	*	-.16	.08	.07	.53	.56	.79	.82	.69
Returns above operating costs	.01	-.18	.06	-.02	-.15	.16	.10	-.10	.17	.13	.59	.61	.84	.89	.73

	1946-47	1947-48	17-Year Average 1931-48	5-Year Averages 1931-36	1936-41	1941-46
Number of grove records, or average	12	9	9	7	9	11
Total acres of records, or average	192.8	87.8	106.1	53.7	82.8	168.2
Average acres per grove	16	10	11	8	9	16
Average age	24	27	20	18	20	22
Number trees per acre	61	70	64	62	66	62
Percent trees GRAPEFRUIT	98.4	97.3	98.9	99.5	98.8	98.7
Boxes harvested per acre	367	463	320	223	333	367
Costs per acre:						
Labor, power, and equipment	$ 93.04	$102.56	$ 45.55	$ 34.66	$ 34.00	$ 47.08
Fertilizer materials	78.84	80.75	50.89	45.39	41.44	54.27
Spray and dust materials	20.21	13.60	10.46	8.90	8.64	11.28
State and county taxes	6.28	12.39	7.68	9.75	6.77	5.86
Miscellaneous	3.35	8.75	3.83	2.06	5.65	2.89
Total operating costs	201.72	218.05	118.41	100.76	96.50	121.38
Interest on grove valuation @ 6%	24.19	29.88	25.30	30.55	24.56	20.11
Total cost without owner supervision	225.91	247.93	143.71	131.31	121.06	141.49
Returns per acre:						
Returns from fruit	204.38	103.90	196.07	89.27	129.20	386.52
Net returns	-21.53	-144.03	52.36	-42.04	8.14	245.03
Returns above operating costs	2.66	-114.15	77.66	-11.49	32.70	265.14

	1946-47	1947-48	17-yr. Avg. 1931-1948	5-yr Averages 1931-36	1936-41	1941-46
Costs per box:						
Labor, power, and equipment	.25	.22	.14	.16	.10	.13
Fertilizer materials	.21	.17	.16	.20	.12	.14
Spray and dust materials	.06	.03	.03	.04	.03	.03
State and county taxes	.02	.03	.03	.04	.02	.02
Miscellaneous	.01	.02	.01	.01	.02	.01
Total operating costs	.55	.47	.37	.45	.29	.33
Interest on grove valuation @ 6%	.07	.06	.08	.14	.07	.05
Total cost without owner supervision	.62	.53	.45	.59	.36	.38
Returns per box:						
Returns from fruit	.56	.22	.61	.40	.39	1.05
Net returns	-.06	-.31	.16	-.19	.03	.67
Returns above operating costs	.01	-.25	.24	-.05	.10	.72

* Less than $0.005

STATE PLANT BOARD QUARANTINE ACTIVITIES

ARTHUR C. BROWN
Plant Commissioner
Gainesville

I am happy to have the opportunity to talk to this assembly of growers about plant quarantine problems. I shall confine my remarks chiefly to a discussion of the blackfly situation in Mexico, the Oriental fruit fly situation in the Hawaiian Islands, and to a change in the manner of inspecting foreign baggage by Customs which is now being considered by the Secretary of the Treasury.

The spiny citrus whitefly, or blackfly, (*Aleurocanthus woglumi* Ashby), is well established in Mexico and is moving northward towards the citrus plantings in Texas, Arizona, and California at a rapid rate. This insect was originally found in British India by Dr. R. S. Woglum, and was named in his honor. In his opinion, this pest can more quickly reduce a citrus tree to a stage of unproductiveness than any other insect he has observed.

Blackfly was first reported from the Western Hemisphere when it was found in Jamaica about 1913. Since that time it has spread into Cuba, the West Indies, Panama, and Mexico. About twenty years ago, largely through the interest and efforts of the State Plant Board of Florida, our federal government sent collectors into India and Burma to search for natural enemies of this pest. Several parasites and predators were found and sent to Cuba and the Bahamas, where some of them became firmly established. One predator, *Eretmocerus serius* Silv., has flourished in those islands, with the result that citrus blackfly is no longer regarded as a serious pest in those localities. Blackfly was found in Key West, Florida, in 1934. Eradication measures providing for the application of an oil spray to all host trees was started immediately, with the result that eradication was completed in 1937. The last live forms were found on February 27, 1937. It is not known to be present anywhere in the United States.

Although blackfly was first reported from Mexico in 1935, nothing worth while was attempted in the way of control. Several private agricultural concerns brought in the predator from Cuba, but this insect was apparently unable to become established in the higher and drier atmospheric conditions encountered in Mexico. In 1947 citrus growers in Arizona and California awoke to the fact that blackfly was firmly established on the west coast of Mexico as far north as Empalme, a town located about 270 miles south of the Arizona line, and, unless its northward spread was checked, it would undoubtedly find its way across the border. These growers raised a fund of $25,000 and, with the permission of officials of the Mexican Government, sent Dr. Woglum, at that time Entomologist of the California Fruit Growers Exchange, together with a number of assistants and spray machines, into the Empalme area to attempt to bring the blackfly under control. This work was continued until May 1948, when the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, with an appropriation of $100,000 provided by Congress, went into Mexico to undertake research investigations on the life history and methods of control of this insect and also to finance an expedition into India and Burma for the purpose of finding additional natural enemies that would flourish under Mexican conditions. A cooperative agreement was entered into between the Bureau officials and the Mexican Government and a plan of operation was adopted. The Mexican Government as far back as 1947 promulgated quarantines for the purpose of preventing the movement of infested plant material from the areas in which blackfly was known to be present. Dr. A. C. Baker, In Charge of the Bureau's Division of Fruit Fly Investigations at Mexico City, was placed in charge of the Bureau's work. Mr. J. C. Cooper, an entomologist of the Bureau with considerable experience and training in control activities, was placed in charge of the field work.

Field headquarters were established at Empalme, in the State of Sonora on the west coast, and at Valles, State of San Luis Potosi, located about seventy-five miles southwest of Tampico. There are large commercial plantings of citrus trees in the Valles area. Participation by the Bureau was confined to research investigations, the search for natural enemies, and the development of effective control measures. No authority was provided for inspectional purposes to delimit the infested area or for actual field control activities. Special attention was paid to the training of employees of the Mexican Department of Agriculture in order that they might become proficient in the effective application of spray materials.

Under the terms of an appropriation in the sum of $190,000 passed by Congress for continuation of blackfly investigations during the current year, the Bureau will continue these activities and, in addition, make surveys for the purpose of delimiting the infested areas, cooperate with the Mexican Government in the enforcement of quarantines, and apply control measures at points where there is a risk of dissemination of blackfly northward towards the border.

The blackfly situation in Mexico is not an encouraging one and the prospect for preventing its entry into the United States is less encouraging. According to a report made by a representative of the Mexican Government, Senor Horacio Aburto, at a recent meeting of the Western Plant Board, the number of states in Mexico in which blackfly is present increased from 10 as of June 1948, to 17 as of June 1949; and the number of infested counties increased from 73 to 152 during the same period. At present there are possibly 2,000,000 citrus trees known to be infested with blackfly. This is one eighth of the 16,000,000 citrus trees reported as growing in Mexico. In this connection it should be stated that very little work has been done in Mexico for the purpose of discovering all the infested properties; and furthermore, that citrus is only one of some 150 species of plants reported as hosts of blackfly. At the present time this pest is established along the west coast of Mexico from a point close to the southern border northward to Empalme, 270 miles south of the border. In recent months it has spread northward from the Valles area into Victoria and to Monterrey. Monterrey is only 130 miles by air from Brownsville, Texas.

It has been estimated that 400 spray units would be required to spray some 2,500,000 citrus trees growing in the known infested areas. We are informed at the present time that there are only 96 units available. The Mexican Government may be in a position financially to furnish all the spray units required, together with control materials, and a field force sufficient to operate the machines, make surveys, and to enforce quarantines at railway, motor vehicle, and airport terminals, as well as on the many roads leading out of the infested areas. If these funds are not forthcoming, there is nothing to keep blackfly from moving northward into the United States.

What is being done by the authorities to keep blackfly from crossing the border in commercial shipments of plants and plant products, motor vehicles, or in parcels and baggage carried by travelers? According to information at hand, inspectors of the Bureau are stationed at the principal ports of entry for rail and motor vehicles. All plant material that crosses the border in freight cars or motor vehicles is subject to examination or fumigation. Small lots of plants observed by inspectors in airplanes, motor vehicles, or in passengers' baggage are examined and if they are free from plant pests they are released; but if infestation is found they are either fumigated or destroyed. The State of Texas has provided $40,000 for use in plant quarantine work on the border. At ports on the Mexican border, as elsewhere in the United States, plant quarantine inspectors must, and do, work in the closest cooperation with Customs inspectors, who alone have the right to stop shipments of commodities entering the United States and to open baggage for examination. In the past, plant quarantine inspectors on the Border have worked side by side with

Customs. Recently, however, the powers that be at Washington inaugurated a system of inspection of incoming motor vehicles which could relegate the plant quarantine inspection service to a position of minor importance and effectiveness.

Oriental Fruitflies in the Hawaiian Islands

The second insect to be discussed is the Oriental fruit fly in the Hawaiian Islands. The fruitfly problem in Hawaii really includes three destructive fruitflies:

1. Melon Fly (*Dacus cucurbitae*)—introduced 1897.
2. Mediterranean Fruitfly (*Ceratitis capitata*)—discovered 1910.
3. Oriental Fruitfly (*Dacus dorsalis*)—introduced about 1944 or 1945, probably by American troops returning from Saipan. The entire group of Hawaiian Islands were found to be infested in less than two years after the introduction of this pest.

Although a recent introduction into the Hawaiian Islands, the Oriental fruitfly has proved itself to be a major fruit pest, far exceeding in destructiveness the Mediterranean fruitfly which it has almost completely displaced in the common edible fruits produced in Honolulu and its vicinity. It attacks a greater variety of fruits and vegetables than the Mediterranean fly. (Med. fly—72 hosts, Oriental fruitfly—104 hosts.)

Eradication was not undertaken because of the failure of the 3 year fight against the Mediterranean fruitfly in Hawaii. So many host plants were inaccessible in deep ravines that eradication of Mediterranean fruitfly was not possible. This same condition would have existed on an even wider scale with the Oriental fruitfly since it was spread over all of the islands soon after its introduction.

Several things are being done in the islands to control this pest and to prevent its spread to the mainland. These include a world-wide search for parasites for biological control; chemical control experiments; and trapping.

Mr. Colin Lennox, President of the Board of Agriculture and Forestry, Territory of Hawaii, in a paper read before the Western Plant Board, June 1949, by Mr. C. E. Cooley, United States Department of Agriculture, made the following statement with regard to biological control of fruitfiies in Hawaii:

"Any permanent reduction in the fruitfly populations in Hawaii will be through the means of biological control. This phase of the work has therefore been given the greatest attention to date. There are few natural enemies of the fruitflies in Hawaii at present and those which exist exert a minor control. The melon fly is kept under minor control with the help of a Braconid wasp (*Opius fletcheri*). The Mediterranean fruitfly is kept under fair control in thin-fleshed fruit by four wasp parasites (*Opius humilis, Diachasma tryoni, Diachasma fullawayi,* and *Tetrastichus giffard'anus*). None of these parasites exert any control over the Oriental fruitfly."

Entomologists searching for parasites of the Oriental fruitfly in the Federated Malay States for over a year have been sending weekly shipments of parasitized pupae to Hawaii. From this material three Braconid larval parasites of *Dacus dorsalis* have been successfully reared in large numbers and liberated throughout the Territory. They are now being recovered in good numbers indicating that they are well established. These parasites are *Opius longicaudatus, Opius persulcatus,* and *Opius incisi.* The material has also yielded three additional parasites which are still under study under quarantine conditions to determine whether or not they have secondary parasitism characteristics. The degree of control exerted by these new larval parasites on Oriental fruitfly is not definitely known at this time.

In addition to the entomologists in Malaya, there are also entomologists in South Africa and India looking for parasites of Oriental fruitfly.

To June 1949, 61,000 *Opius longicaudatus,* 8,000 *O. persulcatus,* and 5,000 *O. incisi* had been liberated in Hawaii. All three are now well established there.

Experiments are being conducted to evaluate a number of insecticides for use in the field and for use in aerosol mixtures to spray departing planes.

Mr. Lennox states that until such time as biological control agents are able to reduce fly populations to a negligible number there will be continuing need for protecting general agricultural areas where crops are reaching a stage of maturity where they may be seriously endangered by fly damage. This means the use of chemical agents, traps, and bait.

DDT has caused marked reductions in populations where it was used in shrubbery, weeds, and brush areas adjacent to fruiting areas.

Traps are useful in checking fruitfly populations while insecticides are being tested, and in reducing fly populations around airports. As high as 2500 Oriental fruitflies have been taken in a single trap in a day. Most of the flies caught in these traps are males because no satisfactory lure has been found for the females. The males are attracted by oil of citronella.

Traps are operated on surface vessels to determine whether or not adult fruitflies gain entry to such vessels. None had been taken in these traps to June 1949.

Controls Set Up To Prevent Movement of Fruitflies from Infested Areas

Pre-treatment of commodities and quarantine are the principal means by which it is hoped the serious fruitflies of the Hawaiian Islands can be kept from reaching the United States. Much additional work needs to be done in the pre-treatment field to insure the safe movement of the maximum number of fruits, vegetables, and flowers.

All horticultural material and passengers' baggage shipped from Hawaii to the mainland by airplane receives a pre-flight inspection. All fruitfly hosts found and not properly treated to meet quarantine requirements are rejected. All treating plants are under strict supervision of Federal or Territory inspectors.

All planes are given two aerosol sprayings before departing for the mainland—one before passengers are loaded and another after the passengers are aboard and just before the plane takes off. For the first treatment an agricultural spray too strong for use around humans is used.

The fruit flies are known to infest host material in Hawaii from sea level to elevations of 5,000 feet. There are some indications that at the cooler elevations ranging from four to five thousand feet the Mediterranean fruit fly dominates the Oriental fruit fly in the same host material, while at the low elevations the Oriental fruit fly dominates the Mediterranean fruit fly. We are told that at these lower levels the Oriental fruit fly, an aggressive insect, has practically driven the Mediterranean fruit fly out of infested areas. Studies were made during the past year on the capacity of the Oriental fruit fly to carry on its life cycle at high elevations, where temperatures drop to freezing and are comparable to the semitropical conditions of the United States. These studies are still in progress, and no conclusive information is available at this time.

The war against Oriental fruit fly in the Hawaiian Islands is being waged by private and public agencies. The Hawaiian Sugar Planters Association, the Pineapple Institute, the Board of Agriculture and Forestry, the Agricultural Experiment Station of the Territorial Government, and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture are all contributing funds and personnel to the control and investigational program.

As is to be expected, residents of California are greatly disturbed by reason of the presence of this fruit fly in the Hawaiian Islands and are concerned with respect to the possibility that it might be introduced into that state. Indicative of this feeling are several pieces of legislation enacted by the last Assembly:

S. B. 553—To appropriate $34,800 to the State Department of Agriculture for Oriental and other fruit fly investigations, including trapping, surveys, quarantine, and studies in treatment of host fruits. Provision is also made for sending to Hawaii to determine susceptibility to infestation fruits grown in California which are not to be found in the Hawaiian Islands.

A. B. 1402—To appropriate $100,000 to the Department of Agriculture for eradication of Oriental fruit fly in the event it makes its appearance in California and for indemnity payments for such crops as it may be necessary to destroy during the course of the eradication program.

A. B. 1403—To appropriate $165,000 to the Regents of the University of California for research investigations in connection with the Oriental fruit fly.

In the event that Oriental fruit fly makes its appearance in any of the Pacific or Southern States, we may expect a wave of hysteria which will result in the imposition by uninfested states of quarantines of every kind and description, some of which may cause more financial loss to affected states than the fly itself. To forestall such action, the National Plant Board, at its recent meeting in Chicago, acted favorably upon the suggestion offered by a representative from California and the writer to the effect that the Chief of the Bureau of Entomology and Plant Quarantine draw up for the consideration of state officials a model interstate quarantine which would provide a uniform and sensible measure for the protection of the several states.

The National Plant Board also requested the Chief of the Bureau of Entomology and Plant Quarantine to discuss with the Secretary of Agriculture and other appropriate governmental officials the need for the governments of Canada and Mexico and countries in Central and South America to promulgate and enforce quarantines governing the movement of untreated Oriental fruit fly host material into those countries from Hawaii. This action is necessary in order to prevent the establishment of this pest in these countries and its subsequent movement into the United States.

By reason of the movement into Miami of large numbers of aircraft each year, there is a real risk of entry of destructive fruit flies. During the past year, inspectors of the State Plant Board carried on a trapping survey in the Dade County area, and in addition examined thousands of soft-bodied fruits. A total of 112 man-days was devoted to trapping activities and 600 man-days were devoted to examination of fruits within a radius of thirty miles of Miami. No new or injurious insects were collected or observed during the course of these two surveys.

Inspection of Foreign Baggage by Customs

I now come to the third and last matter for discussion, namely, a proposed change in the manner of inspection of baggage brought in by passengers from abroad, a change which, if adopted by officials of the United States Bureau of Customs, will open wide the doors for the unsupervised entry of pest-ridden plant material from all over the world. I use the words "all over the world" advisedly, for plant material from 95 foreign countries and possessions was intercepted by our inspectors last year.

As you know, it is the duty of inspectors of the Bureau of Customs, among other things, to open all baggage except that owned by individuals who travel under a diplomatic visa, for examination to determine whether or not dutiable or prohibited commodities are present and, when such are found, to take appropriate action. Foreign plant quarantine inspectors, on the other hand, do not possess these broad powers and in the enforcement of foreign plant quarantines must, therefore, work in close cooperation and harmony with Customs inspectors. Quarantine inspectors "stand by" in the examination room ready to take charge of such plant material as may be observed by the Customs inspectors.

In recent years Customs has been under fire from certain quarters and has been charged with unnecessarily delaying the movement of airplane passengers through ports of entry by reason of the need for compliance with a number of Customs regulations. Several years ago, President Truman provided for the establishment of an Air Coordinating Committee, a sub-committee of which is the Committee on the Facilitation of International Air Travel. Representatives of Customs, Immigration, Public Health, the Departments of State, Commerce, and Agriculture, and representatives of the aviation industry sit on this Committee and discuss ways to adapt our clearance procedures to the needs for air transportation. This Committee has been very active in its attempts to bring about changes in the procedures of Customs, Immigration, and Public Health for the purpose of facilitat-

ing the movement of passengers through ports of entry in the United States. It must be admitted that some of these procedures are outmoded or cause duplication of effort, and should be revised or abolished. At the same time, it is the responsibility of every grower in the United States to keep close watch on the activities of this sub-committee so as to forestall any endeavor which might result in weakening our defense against entry of pest-ridden plant material from abroad.

More recently attention has been directed to Customs procedures from another quarter. About two years ago the Secretary of the Treasury of the United States employed McKinsey & Company, a commercial management survey organization, to make a study of the operations of the Bureau of Customs and to make recommendations which would improve the service performed by Customs personnel and at the same time reduce costs of operation. The Secretary is now studying this report, together with its recommendations. One recommendation that should be a matter of concern to all of us is that Customs discontinue the present procedure of examining all the baggage brought in by passengers from abroad, a procedure which requires the services of a large number of Customs inspectors, and to inaugurate a system wherein only a small percentage of such baggage would be examined. This latter procedure would enable Customs to operate with a much smaller force of inspectors, thereby effecting an economy in operations, and at the same time improve the service by speeding up the movement of passengers through the Customs inspection rooms.

It has been recommended that this type of inspection could be accomplished in one of two ways: (1) by examining a certain percentage of all baggage arriving; or, (2) by examining the entire baggage of a certain percentage of the passengers arriving, the percentage to be determined according to the conditions, information which may be received or from the declarations showing the purchases abroad.

Let us consider the effect such a system of percentage inspection would have on the enforcement of plant quarantines. It is a matter of fact and record that many travelers return to this country with plants, fruits, cuttings, and seeds in their baggage, and that this material is affected with foreign insects and diseases. At Florida ports last year quarantine inspectors removed 40,577 units of plant material from the 833,710 pieces of baggage brought into the State by 327,467 passengers. Live specimens of Mediterranean and other fruitfly larvae, citrus blackfly larvae and pupae, scale-insects, lima bean pod borer, sweet orange scab, and other pests not known to be present in the United States, were intercepted on a number of occasions.

If the powers that be decree that Customs shall examine only a certain percentage of incoming foreign baggage—and the figure of 10% has been mentioned informally—it is a foregone conclusion that the plant quarantine inspectors will not be permitted to examine the other 90% that Customs will pass without scrutiny. This would mean that each year many thousands of parcels of plants or plant products, a considerable portion of which will unquestionably be affected with plant pests—some of major economic importance—will have free and uninterrupted entry into Florida and elsewhere in the United States.

In making this particular recommendation, McKinsey & Company no doubt considered Customs solely as a revenue-collection agency, and overlooked the fact that Customs is also responsible for the prevention of entry of dangerous viruses, unauthorized serums and toxins for treatment of man and animals, immoral pictures and articles, drugs, and narcotics, as well as agricultural products.

The authors also overlooked the fact that the savings that would be made through percentage inspections would be infinitesimal when compared to the expenditures from private, state, and federal sources that would be necessary to control or eradicate such major plant pests as will undoubtedly be brought into this country in plant material carried in baggage that would be passed without examination under the percentage system.

Your Plant Commissioner has participated in several conferences with officials of Customs and the Department of Agriculture, in which he sought further information on the subject of percentage inspection. He left these conferences with the convictions (1) that these officials are opposed to the proposal and (2) that they were under orders not to talk too much. Members of the State Plant Board and the Plant Commissioner and his associates believe that this proposal is of sufficient importance to justify wide dissemination of the proposed change and the arousing of public interest to the end that responsible officials in Washington be advised that the adoption of a percentage system of baggage inspection would bring about a breakdown of our defense against entry of injurious plant pests from abroad, a condition that cannot be allowed to develop.

The State Plant Board has passed a resolution voicing a protest to the percentage system of baggage inspection, and copies have been sent to President Truman, the Secretaries of the Treasury and Agriculture, and members of Florida's Congressional delegation. As a result of the interest aroused by the Plant Commissioner, the National Association of Commissioners, Directors, and Secretaries of Agriculture adopted a resolution similar in wording and distribution. Resolutions of a like nature were adopted by the members of the Southern and National Plant Boards. Growers and representatives of growers' organizations have been informed of this matter. The members of the Florida State Horticultural Society should give serious consideration to the percentage inspection proposed and take appropriate action.

RESOLUTION ADOPTED BY THE STATE PLANT BOARD AT ITS MEETING IN JACKSONVILLE

OCTOBER 15, 1949

WHEREAS, the attention of the State Plant Board of Florida has been directed to the fact that the Secretary of the Treasury of the United States is giving serious consideration to recommendations made by McKinsey & Company, a commercial management survey organization employed by the Secretary to make a study of the activities of the United States Bureau of Customs and to make recommendations that would increase the efficiency of this Bureau and at the same time effect economies in costs of operation; and

WHEREAS, it has been recommended by the McKinsey Company, among other things, that Customs could effect a considerable saving in expenditures for salaries and expenses through a change in the manner of the inspection of baggage brought in by passengers from abroad by the discontinuance of the present system wherein each piece of baggage is examined, a procedure which requires the employment of a large number of Customs inspectors, and by the substitution of a system of spot or percentage inspection wherein only a comparatively small portion of the total number of pieces of baggage offered for entry would be examined, thereby obviating the necessity for the large number of inspectors now employed; and

WHEREAS, the proposed system of spot or percentage inspection would provide for the unsupervised entry annually of many thousands of pieces of baggage, a considerable portion of which will contain plants or plant products from abroad affected with serious foreign plant pests, a statement which is supported by the records of the United States Department of Agriculture and the State Plant Board of Florida (at Florida ports alone last year 40,577 units of plant material were removed from the 833,710 pieces of baggage brought into this country by 327,467 passengers and from which live specimens of Mediterranean fruit fly and other fruit flies, citrus blackfly, scale-insects, lima bean pod borer, sweet orange scab, and many other insects and diseases not known to be present in the state were removed); and

WHEREAS, the repeated entry of any of the major plant pests which have in the past been removed from passengers' baggage would, in all probability, result in the establishment in the United States in general and in Florida in particular of insects and diseases capable of causing serious economic losses to the State's horticultural and agricultural industries and in addition necessitate the expenditure, for control and quarantine purposes, of funds from private, state, and federal sources far in excess of any savings that Customs may be able to achieve through a reduction in personnel; now, therefore,

BE IT RESOLVED by the State Plant Board, in regular meeting assembled at Jacksonville, Florida, this 15th day of October 1949, that it is unalterably opposed to the proposed plan of spot or percentage inspection of passengers' baggage from abroad, a system which would provide for the unrestricted entry from foreign countries of thousands of units of plant material, a considerable portion of which is likely to be affected with insects and diseases capable of causing serious economic injury to the horticultural and agricultural investments of the State and the Nation; and

BE IT FURTHER RESOLVED that the Board's Secretary be and hereby is instructed to send copies of this resolution to President Harry S. Truman, the Secretary of the Treasury, the Secretary of Agriculture, the Commissioner of Customs, members of the Florida Congressional delegation, and to growers and officials of growers' organizations in the State of Florida.

THE FLORIDA CITRUS MUTUAL

ALDEN M. DRURY, *General Manager*

Florida Citrus Mutual

Lakeland

We are just starting another harvesting and shipping season for Florida citrus fruits. Everybody is asking questions about the prospects, but almost everyone believes this is going to be a good and profitable season. They just *feel* that way but aren't sure of facts to support that feeling. I'm going to give you some of those facts.

Recently the United States Department of Agriculture released its forecast of production for all areas for the 1949-50 crop. I quote their figures, together with actual production for the last season, to show where Florida stands in relation to the national supply.

	1949-50 Forecast	Last Season
Florida Oranges:		
Valencias	28,000,000	26,300,000
Early and Midseason	33,000,000	32,000,000
Total	61,000,000 boxes	58,300,000 boxes
California Oranges:		
Valencias		8,398,000
Navel	15,700,000	28,500,000
Total		36,898,000 boxes
Florida Grapefruit:		
Seeded	13,000,000	15,500,000
Seedless	10,000,000	14,700,000
Total	23,000,000 boxes	30,200,000 boxes
Texas Grapefruit	4,800,000 boxes	12,000,000 boxes
Florida Tangerines	4,400,000 boxes	4,400,000 boxes
Apple Production	129,000,000 bushels	88,000,000 bushels

According to reports from California, there are about 5,000 cars of Valencias remaining for shipment, which means another 4 to 6 week's supply. Average sizes are extremely small and quality is poor. California Navels are reported to be of good sizes and good quality but somewhat delayed in maturity. They will not begin to move in volume until after the middle of November. The Crop Reporting Service also shows a very heavy pack of apples in storage and disastrously low prices for that commodity which is highly competitive with citrus. The evidence is not all favorable, and so we need to look at both sides.

Let's look at the dark side first. I am going to list a few of the things that can upset the picture and spoil our prospects if they are not watched carefully and guarded against.

1. We lost a lot of perfectly good fruit as a result of the hurricane. We cannot recover that loss, but can prevent more loss by insisting that fruit going to market is of good quality and worthy of repeat business. This will be especially true of early shipments.

2. We must not let prices reach exorbitant levels that will stifle demand and turn the consumer to other commodities or to citrus from other areas.

3. We must try in every way to keep down our costs of production, packing, processing and transportation which can eat up all the profits.

4. We must see that the quality of frozen concentrates is maintained at a high level, and prevent over-enthusiasm from leading us to lower our standards, which will discredit this product that offers so much promise.

5. We can rush fruit to market without regard to the demand, driven by fear of declining prices, cold weather, or another hurricane, forgetting that such fears and disorderly marketing will surely mean financial losses.

6. We can become involved in legislative upheavals that will destroy confidence in the stability of the citrus industry.

7. Coal and steel strikes—with loss of buying power and possible short supply of tin plate for canning industry.

Now, let's look on the bright side.

1. Our Florida fruit is reported to be of fine appearance and excellent quality; it is a little later in maturity than normal, which means it will miss some of the competition from other producing areas.

2. We have a real national shortage of grapefruit for the fresh fruit market, and prices for this variety will probably be higher than

for oranges. This is only a fair compensation for the grapefruit growers who lost so heavily in the hurricane.

3. Consumer income remains high and buying power warrants good prices for citrus unless too badly affected by strikes in major industries.

4. There is the continuing effect of advertising to convince the public that they require citrus for health and as part of a balanced diet.

5. We are close to the large centers of population which means a favorable freight rate structure compared to the other major producing areas.

6. We have developed and perfected frozen concentrates which will take a large quantity of fruit—perhaps 20 million boxes of oranges this year, or nearly double last year's pack of this item that commands ready consumer acceptance.

7. There isn't any large carry-over of canned juices, or of concentrates, on the grocery shelves, or in warehouses either in the markets or at the canneries.

8. Florida Citrus Mutual is activated and functioning to stabilize markets and improve prices.

What about Mutual? Why is it a favorable factor?

Florida Citrus Mutual is a State-wide organization of citrus growers banded together under authority of the Capper-Volstead Act for the purpose of stabilizing the market and improving the financial returns of its 6,500 grower-members. These growers produce almost 80% of all the citrus fruits of all varieties grown in the State of Florida.

To provide ample facilities to handle the 60 million or more boxes produced by its members, Mutual has more than 250 handlers, both fresh fruit, canners and concentrators, under contract with it. These handlers and processors have agreed to abide by Mutual's recommendations as to fob prices and shipments to the markets. In other words, Mutual expects to correct the adverse factors of disorderly marketing and exorbitant and widely fluctuating prices that can nullify most of the favorable factors mentioned above.

Too high prices stop sales and too low prices stop shipments. In both cases the grower suffers.

Mutual aims to correct these situations and prevent grower losses. It offers the medium through which the growers and handlers can work together to correct those abuses and effectively stabilize the markets. Through Mutual, they can supply the consumers' needs at a price they can afford to pay, and at the same time realize for themselves enough money to again make the growing and handling of citrus in Florida a sound and a profitable business.

What Has Florida Citrus Mutual Done?

Florida Citrus Mutual, because of general recognition by growers, shippers, bankers, civic groups, distributors and handlers in the markets, of the absolute need for correction of the chaotic conditions that have obtained so long, has convinced growers who produce over three-fourths of the entire crop that it is the agency they have been seeking and that it has the power, through concerted effort, to do those needful things referred to above.

Mutual has already demonstrated its value to the Florida grower through its recommendations and allocation of fresh fruit shipments, on a voluntary but industry-wide basis, during the latter part of the 1948-49 marketing season. Control of shipments by this method following the unrestrained flood of fruit and extreme break in the market immediately after the California and Texas freezes resulted in many millions of dollars of increased revenue to the growers of Florida.

How Will Florida Citrus Mutual Accomplish Its Objectives?

Florida Citrus Mutual's plans and objectives are real and solely in the interest of stabilizing the markets, the economy of the State and industry, and the financial security of the grower.

To accomplish this, an organization is being perfected to accumulate data on the markets,

production, prices, supply and demand. The mechanics of an orderly shipping program for Mutual members is being established to render intelligent decisions on the four basic objectives already announced, namely:

1. Regulation of the volume of fresh fruit shipped each week in interstate channels.

2. Control of offerings in the terminal markets—which should result in a consistently improved price level, as well as an increase in the volume of sales in those markets.

3. Determination of the fair fob valuation of fruit for fresh fruit sales.

4. Determination of a fair on-tree price for fruit to be sold to canners, concentrators and processors.

The data on which the above decisions are based will be made available to the handlers and growers to assist them in working out their operational plans. The information should be helpful to the handlers under contract with Mutual in fitting their activities into the picture in accord with the suggestions and recommendations of the fresh fruit sales Manager and his Industry Advisory Committee; (now functioning), those released by the processed fruit sales Manager and his Industry Advisory Committee; and the general price information governing on-tree prices if and when such pricing becomes necessary to stabilize the market.

With this information, Mutual and its contract handlers, even though they control only 75-80% of the production, can make vast strides in improving and stabilizing the marketing practices of the entire Florida industry. How much more effective it would be with the entire industry following the same sort of program.

Many other powers and activities are authorized in the Charter and By-Laws. They involve questions of concern to all growers in the industry. Some of them—in fact, most of them—existing 20 years ago are still with us: freight rates, standardization of containers, research in production and utilization, advertising, financing, and others of a similar nature.

So long as other industry-wide agencies are handling these problems satisfactorily, there is no need for Mutual to invoke its authority. Mutual can accept their findings and make them a part of the information handled through its clearing house facilities.

There is one problem, however, with which Mutual can and should concern itself at once. I refer to some plan of co-insurance against disaster—freeze, hurricane, fruit flies, tristeza, etc. This idea is not new. It has been advanced at meetings of Mutual grower-members, but it has not been followed through because the Mutual Board of Directors has rightly followed a policy of "first things first" and has been busy perfecting its organization and the basic contracts under which grower, canner and shipper can sit down together to solve their common problems.

If such a plan can be worked out and put into practical operation, it will be a wonderful thing for the grower. Our industry staggers under the blow of the August 26-27 hurricane. Losses vary by area and by variety. Wouldn't it have been worth a few pennies per box as premium payment on an insurance policy underwritten by Mutual for its own members if such a policy could have partially reimbursed those growers who suffered losses? I believe this plan merits study. At all events, I personally prefer to try to work out a solution within our own control rather than rush to the government for aid.

There arises also the problem of protection to the individual grower-member of Mutual who has not had a chance to move an equitable share of his crop due to controlled rate of shipment, should some midseason disaster strike and he suffer loss. I do not refer here to the grower who belongs to a cooperative association because most of them have pooling arrangements to take care of equities amongst their growers. I have reference to the member of Mutual who sells his fruit to various Mutual contract handlers. This problem also merits careful study.

Plans should be made also for handling the problem of surplus production through some sort of pooling arrangement if and when the

need for such a plan should arise. Mutual might well devote thought to such a plan for its members, so that the tools and facilities will be ready to hand when that time comes.

You will note that all my remarks have been directed towards perfecting machinery for the Florida citrus grower to use in assuring himself of a sound and profitable industry. He can only have that sort of industry in the final analysis if the price structure is satisfactory. Who really sets those prices? I quote from an article printed in farm and trade papers this past Spring:

> We must recognize, however, that neither grower, nor shipper, nor wholesaler, nor retailer "sets" produce prices. In this, the most competitive of all businesses, prices are established in a free market by the old law of supply and demand.
>
> Food prices go up or down as these two factors—the market supply and the consumer demand—get out of balance with each other, one way or the other.
>
> Limited quantities and superior quality produce on the market shift the balance in favor of higher prices. Excessive quantities or inferior produce shift the balance toward lower prices.
>
> **WHAT CAN WE DO ABOUT IT?**
>
> Fortunately, growers and distributors need not and do not leave so vital a matter affecting their welfare entirely to chance.
>
> Much has been done within the framework of a free, competitive market to help keep the twin factors of supply and demand in healthy balance. And much more can be done:
>
> **Gear Production Closer to Demand,** with greatest emphasis on those varieties enjoying greatest public favor.
>
> **Effect More Orderly Marketing** and equalize distribution so that peaks and valleys in the supply from day to day, and on each individual market, will be minimized.
>
> **Improve Quality,** adhere closer to good grade and pack standards, and keep inferior, unripe, and off-grade produce off the quality market.
>
> **Cut Costs** both in production and distribution so as to narrow the spread between farm and retail price, increase demand, and increase returns to growers.
>
> **Stimulate Demand** through intensive advertising, attractive produce displays, and effective point-of-sale merchandising.
>
> All these things call for teamwork . . . cooperation . . . working together.

So, you see, lots of people are worried by the same problems and many solutions are offered. Other ideas than those expressed here today will occur to all of us as we go along. Some will be workable and practical, others may be desirable, but impossible to attain without complete regimentation of the industry, still others may be lacking in merit. No one has the final answer, but we all have the same problem.

In announcing the list of handlers who had executed contracts with Mutual, on October 1st, A. Vernon Saurman, President of Mutual, said:

"Speaking in behalf of the 6,500 grower-members of Mutual, who have exercised their legal power to organize the industry and who have stood firmly by the organization through many months and difficult situations, I express our deep appreciation to these handlers who have pledged to do their part in stabilizing markets and prices.

"It will be a welcome change in the Florida picture to have a skillful, experienced group of operators working together in a well-planned marketing program instead of continuing the ruthless competition which has proved so disastrous.

"Mutual's success will depend upon continued loyalty to the principle upon which it was founded: fairness, good will and unity among those who grow the fruit and those who market it for them as shippers, canners and concentrators."

Mr. Edward Ball, of the Florida National Group of Banks, which underwrote the first operating loan for Mutual, stated:

"The participating banks are happy to have this opportunity of serving the 6,500 growers of Florida who comprise Mutual. Florida's economy can never be well balanced with her citrus industry as sick as it has been for the past several years.

"We recognize in the creation of Mutual, an organization possessed of necessary power to stabilize the industry and its orderly marketing program has already produced encouraging results.

"As members of the State Bankers' Association, we have endorsed the recommendations of the Association made in behalf of Mutual while Mutual was in the formative state, both as a group and as individual banks. I definitely believe that Florida's citrus industry as now mobilized is in a position to safeguard the industry now and for the future and that Mutual is the greatest contributing factor to this improved condition."

THE FLORIDA CITRUS COMMISSION

ROBERT C. EVANS, *Manager*
Florida Citrus Commission
Lakeland

I am glad to have the opportunity today to tell you something about the work of the Florida Citrus Commission. Although the Commission has just completed its fourteenth year of operations, there are no doubt many growers who have only a vague knowledge of what it is doing. We feel that all growers should be familiar with its activities and we welcome the opportunity to discuss the subject with you.

The Commission was established by an Act of the Florida Legislature in 1935. The leaders in the citrus industry at that time recognized the need for one organization to handle the various regulatory measures. It was also recognized that there was a need for an advertising and merchandising program to assist in the marketing of increasingly larger crops. The Commission was established under the State laws in order that the police powers of the State might be available for enforcement of the program.

There are 12 members of the Commission who are appointed by the Governor. These members must be citrus growers and derive a major portion of their income from growing citrus. Some of them are also engaged in the shipping and processing of citrus fruits; therefore, all segments of the citrus industry are represented. During its fourteen years of operations, more than 50 growers have served on the Commission. These men devote most of their time to the business of operating the Commission and they receive no pay for this work.

The Commission's operations cover three general fields of activity: (1) Advertising and Merchandising, (2) Research, and (3) Regulatory and General Activities. Probably the most important of these is advertising and merchandising because it is through this work that the Commission extends the most direct assistance to the industry in the marketing of its crops. The Citrus Code provides for an assessment of 2 cents per box on oranges, 3 cents on grapefruit, 4 cents on limes and 5 cents on tangerines. This provides a fund of slightly over 2 million dollars annually, most of which is expended for advertising and merchandising activities.

At the present time the Commission has a force of 25 Sales Service representatives stationed throughout the Florida marketing territory. These men have been schooled in the "know-how" of merchandising. Their principal objectives are (1) to secure maximum distribution for Florida citrus products in wholesale and retail outlets in order to meet the consumer demand which the advertising program is expected to develop, (2) secure for Florida citrus products prominent display at the point of purchase, and (3) encourage dealer support for these products through regular and prominent listing in his own retail advertising and through active promotion by store personnel.

In order to obtain maximum distribution for Florida citrus products our merchandising men constantly remind the trade of (1) the *high quality* maintained through rigid inspection, (2) the proved *volume turnover* possibilities and (3) the *consistent profit* to be derived. The men are assisted in this work by the use of a Sales Portfolio prepared in advance of each season's campaign. This portfolio contains merchandising ideas that have proven successful and copies of the various advertisements that will appear from time to time, including names of publications and insertion dates. This is a valuable aid in persuading dealers to plan their local advertising so as to obtain maximum benefits from the Commission's advertising program.

There is an axiom among merchandising men that "the more it shows, the quicker it goes." In line with this, the Sales Service representatives devote a substantial part of their time in arranging for Florida citrus fruits and products to be displayed at the most desirable locations within the stores.

Various types of displays known to be sure-fire volume builders are demonstrated and recommended. Tieing-in directly with this activity is the use of attractive and colorful store display materials. During the 1948-49 season more than 2 million pieces of individual point-of-sale display material were used.

In the past these merchandising men have put on demonstrations of various citrus products such as orange juice and frozen concentrate. This year each man is being supplied with an attractive juice bar and it is contemplated that the number of demonstrations will be greatly increased.

The number of sales service men has been increased from 17 last year to 25 this year, but even this expanded force is not sufficient to service all retail stores. However, by contacting the headquarters of corporate chains, voluntary groups, super markets and the large wholesale units, a wide coverage of outlets is obtained. Last season more than 22,000 individual contacts were made covering the leading independent, cooperative and chain store retail outlets.

The men forward reports to the Lakeland office each week where they are condensed and mailed to all sales managers in Florida. These reports cover condition and prices of fruit, juices, and competing products as well as general market conditions and reaction of the trade. We have received many letters from the industry commenting on the value of this service. From time to time the men are requested to make surveys to obtain special information needed by the industry.

At this point I should like to mention the Commission's Convention activities. We have one man who devotes his entire time to attending conventions and demonstrating Florida orange juice and other citrus products. Such demonstrations are for the most part limited to conventions of doctors, dentists, nurses, dietitians, nutritionists, and groups in the food fields such as National Association of Retail Grocers, and other similar organizations. Last year we served approximately 66,000 cups of citrus juice at these conventions. In addition, we served approximately 100,000 cups of juice at special events and in store demonstrations. We receive requests for such demonstrations from many conventions where we cannot participate because of personnel and budget limitations.

You have all seen the Commission's attractive and colorful advertisements in leading national publications such as Life, Saturday Evening Post, Ladies' Home Journal, Better Homes & Gardens, McCalls and Farm Journal. These publications reach millions of families. It has been said that in order to obtain and hold a prospect's interest, a salesman should base his appeal primarily on health, happiness and financial gain. Most of our advertising hammers away at these points. Our big story, of course, is the health value of citrus fruits and along with it we stress the big values available at the neighborhood stores in Florida citrus fruits and products. The health values and the attractive prices at which citrus fruits and products have been available in the past are, in my opinion, the principal reason for consumer demand keeping pace with the tremendous increases in production.

The Commission has budgeted for the 1949-50 season approximately $1,445,000.00 for consumer advertising. This includes $1,335,000 for the basic campaign in magazines and newspapers, $65,000 in professional publications with circulation in the medical, dental, nutritional, dietetic and other allied fields, and $45,000 for general publicity where the principal effort is to supply the food editors of magazines, newspapers and radio stations with citrus material. Through these media we obtain many thousands of dollars of free space.

The Commission from time to time prepares for general distribution booklets designed to increase the consumption of citrus fruits. During the 1948-49 season 150,000 colorful consumer recipe booklets entitled "Florida Citrus Fare" were produced and on the basis of the present demand, the supply will soon be exhausted. It has been a very popular item. We also produced for distribution to dietitians, nutritionists, home economists and teachers a 40 page booklet entitled "Citrus Fruits and The

Nation's Health." About 40,000 of these booklets have been mailed to the profession and we are continuing to receive daily requests for copies. We have also just completed production of a 32 page booklet entitled "Citrus Fruits In Health and Disease." A copy of this booklet will be sent to every physician in the United States. The recommendations of these professional groups to their patients and clients have an important influence on the usage of citrus fruits and products.

During the past several years the Commission has subscribed to market research services from which a wealth of vital market information is made available to the industry. The A. C. Nielsen Company supplies data on sales, purchases, prices, distribution and inventories of citrus juices and frozen orange concentrate. The Industrial Surveys Company supplies information on fresh and canned citrus fruits and competing fruits and juices. In addition to supplying valuable information to the industry, these reports serve as a guide to the Commission and its advertising agencies in planning advertising programs, particularly since the reports supply the various data by geographical areas, city sizes and store types.

Now, let's turn to the Commission's Research activities. Under the citrus laws up to 5 percent of the income may be used for citrus research. On the basis of present income, this provides approximately $100,000 a year for this activity. The Commission has a Research Director and 12 research employes. This department is constantly working to develop new products and to improve the processes for the various citrus products already in production. Research is one field of activity where it may take years to come up with something of great value to the industry.

I believe that the outstanding accomplishment of our Research Department has been its work on frozen orange concentrate. Our men worked on this for several years before developing the process now in use. Their patent on this process was assigned to the U. S. Department of Agriculture as a public service patent, number 2453109. I believe that this one development may eventually more than justify all the funds ever expended by the Commission for research.

During the 1948-49 season approximately 10 million boxes of oranges were utilized for frozen orange concentrate. Industry leaders estimate that 20 to 25 million boxes will be utilized for frozen concentrate in the 1949-50 season. This would amount to 35 to 40 percent of our total orange production. Production of this product began in a modest way about 4 years ago when 225,000 gallons were produced. Last year 10 million gallons were produced. Sales at the retail level have skyrocketed and it is believed that the surface has just been scratched on the potential market. Information developed by one of the market survey services to which the Commission subscribes shows that 51% of all stores now have facilities for frozen foods. This compares with 41% about 9 months previously. This expansion is generally credited to the popularity of the frozen orange concentrate which is now by far the leader in sales volume.

In June-July 1949, 37 percent of all U. S. retail stores purchased one or more brands of orange concentrate. This compares with 16 percent last October-November and 26 percent in February-March. In June-July 1949 this product accounted for 19.6 percent of the volume of the total citrus juice market which was a larger share than for blended orange and grapefruit juice. On a dollar volume basis the product accounted for 25.1 percent of the consumer's dollar which was second only to orange juice. I quote these figures simply to give you some of the reasons why many growers and processors are so optimistic about the future of this product and what it may mean to the industry. I believe there is general agreement that the development of the production process for this product is one of the outstanding achievements of the Citrus Commission.

I will not attempt to enumerate all of the other projects with which our Research Department is now concerned. One of the more important is decay-control. We have been

working on this for several years and have found two or three compounds that control stem-end rot to a remarkable degree. However, before they can be used commercially they must be cleared as to toxicity and other properties by the Food and Drug Administration.

Most of you growers receive copies of the Spray and Dust Schedules each year. These schedules are prepared by the Better Fruit Committee which includes representatives of several research agencies, and they are printed and distributed by the Florida Citrus Commission. Last year 20,000 copies were distributed.

The Citrus Code provides that up to 3 percent of the citrus advertising tax funds may be expended in the handling of transportation problems and to employ rate and transportation experts to handle these problems. For a number of years the Commission has employed the Growers and Shippers League of Orlando to handle this work. This agency through its action in obtaining reductions in freight and icing rates and in obtaining delays and suspensions in proposed increases in such charges has saved citrus growers several million dollars. It has obtained modifications and cancellations of restrictive orders governing the use of refrigerator cars, diversion privileges, and loading requirements. This activity of the Commission has been worth many times its cost to the industry.

In addition to the foregoing activities, the Commission is charged with the responsibility of promulgating and administering rules and regulations governing various phases of the citrus industry's operations, and also engages in certain general activities for the purpose of benefitting the industry. The rules and regulations cover the following:

1. Establishing grade standards for fresh and canned citrus.
2. Prescribing methods of testing and sampling for maturity and grade inspection.
3. Registration of labels.
4. Prescribing containers to be used for shipping citrus fruits.
5. Marking of containers.
6. Specifications for use of Color-Added.
7. Stamping of citrus fruits.
8. Establishing embargoes against shipment of freeze damaged citrus fruits.
9. Handling of applications for licenses by citrus dealers.
10. Coloring Room practices.
11. Safeguard against the canning or processing of unwholesome or decomposed fruit.

The Commission investigates all applicants for license as a citrus fruit dealer. Last season 1,068 dealers were licensed. Each citrus dealer is required to post a surety bond which is designed to afford some protection to growers against improper returns and failure to carry out contracts by citrus dealers.

Through the years the Commission has intervened in various matters affecting the welfare of the citrus industry. Throughout the war years it represented the industry in negotiations with the government on ceiling prices, war production board orders, transportation and other matters. From time to time various issues arise in which the Commission is requested to negotiate for the industry. We have recently been active in requesting our Congressional delegation and all members of the Senate Agricultural Committee to incorporate in the new agricultural bill provisions under which more funds will be available for the purchase of citrus fruits or citrus products if and when the occasion for assistance arises.

Many of the activities of the Commission have been in the nature of those performed by a service organization. After all, the value of the Commission is measured by its usefulness to the industry. It has been the policy of the Commission to assist the industry in every way possible in the solution of its problems. Differences of opinion among the various factors in the industry are often resolved at the Commission meetings. These meetings serve as a forum where any grower, shipper or canner may present problems affecting the industry. As a rule the Commission takes whatever action the majority of the industry desires if it is considered feasible,

practical and in conformity with the citrus laws and regulations.

If you could spend a few months in the Commission office you would be amazed at the number of inquiries received from persons all over the country. Many of these persons request information concerning the citrus industry or its products. One party wants to know something about a new process for extracting citrus juices; another is interested in investing his life's savings in a grove and seeks advice and information. Quite a few people submit ideas, recipes, and sure-fire sales aids they wish to sell. Some of the most interesting letters we receive are from people commenting on the quality of our citrus fruits and products. These comments and observations cause those of us associated with the Commission to be quite conscious of the need for the industry to put great stress upon supplying consumers with *quality* products. We receive many letters commenting on the fine quality of our products, but we also receive some adverse comments. I think one of the biggest factors that will determine the eventual market for our frozen orange concentrate is QUALITY. Up to now quality has been good, with few complaints being received. It is my opinion that this is the principal reason for the tremendous expansion in the market for this product and we should all be a self-appointed committee of one to advocate and stress quality for *all* of our citrus products. The best advertising and promotion program in the world won't be much help in selling poor quality products.

The scope of activities of the Commission has expanded with the growth of the industry. When it was established in 1935, the Commission had only a few employees and the income that year was $550,000, the production being only 29.5 million boxes. The production is now ranging close to 100 million boxes with a resultant income in excess of $2,000,000.

The industry has been faced with the problem of marketing increasingly larger crops. This has been a problem that has been with us for many years. I believe most of you will agree that, in general, the problem has been met with success. It is true that there have been years of adversity and loss, but for the most part our groves have been a good investment. However, we can't rest on our laurels. We must continue aggressive advertising, merchandising and research programs. We must investigate and explore new ideas, new methods, new outlets. We must hold production costs to a minimum. We must do some aggressive consumer educational work. And above all we must produce good fruit and maintain a high standard of quality for our citrus products.

The Florida citrus industry does things in a big way. That is why we have weathered the economic storms in the past that have wreaked havoc among some of the other fruit industries. We must continue to do things in a big way if we are to prosper. Those of us associated with the Florida Citrus Commission are proud of the part it has played in the progress of this great citrus industry.

OBSERVATIONS ON BORON DEFICIENCY IN CITRUS

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Although the presence of boron in plants was discovered nearly a century ago, it was not shown to be an essential element for the normal growth of plants until 1914[1]. The first demonstration of the essential nature of this element for the growth of citrus was made by Haas[2] in 1929, by the use of sand cultures. Grapefruit, lemon, and orange all failed to develop properly in those cultures from which boron was withheld. Several deficiency symtoms were described in detail by Haas and Klotz in 1931[3]. Roy[4] induced boron deficiency in grapefruit in sand culture in Florida in 1943 and found that arsenic induced deficiency symptoms even though boron was present in amounts that would seem adequate. During

the past three years we have grown young Valencia trees under conditions of very limited boron supply and several symptoms have resulted which appear to have some diagnostic value in the field. Gumming of the fruit, lumpiness, and a hard, dry fruit are almost universally recognized as characters which result from the lack of an adequate supply of boron. Leaf symptoms, on the other hand, are not generally recognized. The present report lists the chief fruit and vegetative symptoms of boron deficiency from previous work and those found in our outdoor sand-culture experiments at Orlando (table 1). On the basis of these symptoms, or a large number of them, several groves in central Florida were suspected of showing varying degrees of stress due to lack of this element during the very dry winter and spring of 1948-49. One grove was selected for detailed study, and all of the available evidence seems to indicate that boron deficiency was present under field conditions. Since the only reported case of definite boron deficiency in a citrus orchard appears to be that described by Morris[10] in South Africa, the present findings are given in some detail.

Boron deficiency symptoms in the fruit have frequently appear in Florida in conjunction with application of lead arsenate, and boron sprays are helpful in remedying the situation. Similar symptoms have been noted[4 5] periodically in the absence of arsenic antagonism; but a response to soil applications of boron was not evident, while toxicity symptoms sometimes resulted and the deficiency symptoms usually disappeared regardless of whether boron was applied or not. A dry soil condition has been found to induce deficiency symptoms in apples[1] and other plants even though the soil is not necessarily deficient in boron. Citrus rootstocks have been shown[6 12 13] to influence the boron supply to the scion. Sour orange roots are relatively poor feeders for this element, while grapefruit, trifoliata, and Cleopatra mandarin are among the best of the tested rootstocks for supplying it. Sweet orange and Rough lemon are intermediate in this respect.

The grove selected for study consists of about 10 acres on Lakeland (formerly classified as Norfolk) sandy soil near Eutis, Florida. The pH of the topsoil is about 5.5. It is planted almost equally to three orange varieties (Washington Navel, Hamlin, and Temple), all on sour orange stock. The trees are about 9 years old and have received uni-

TABLE 1.

GROSS SYMPTOMS OF BORON DEFICIENCY IN CITRUS AS NOTED BY VARIOUS WORKERS

Symptoms	Haas	Roy	Morris	Smith & Reuther
1. Curling, or buckling, of leaves, either upward or downward (fig. 1)	Yes	Yes	—	Yes
2. Yellowing along midrib and lateral veins; normal thickness; tendency to abscise prematurely (fig. 1)	Yes	—	—	Yes
3. Enlargement of midrib and lateral veins (fig. 1)	Yes	Yes	—	Yes
4. Splitting and corking of veins on upper (ventral) side of leaf	Yes	Yes	No	Yes*
5. Some leaves thickened; somewhat leathery, but brittle and persistent	Yes	—	—	Yes
6. Some deformities of thickened leaves, such as blunt, notched, and heart-shaped apices	—	—	—	Yes
7. Rosetting or whorled clusters of leaves due to shortened internodes of stem	—	—	—	Yes
8. Brownish green leaf color, lack of luster	Yes	—	—	Yes
9. Multiple buds	Yes	—	—	Yes
10. Premature defoliation of some stems	Yes	Yes	Yes	Yes
11. Dieback of young, defoliated stems	Yes	Yes	Yes	Yes
12. Gum pockets in internodes of stem	Yes	—	—	Yes
13. Normal to heavy blossoming	No	Yes	—	Yes
14. Excessive fall of young fruit	Yes	Yes	—	Yes
15. Gumming of albedo layer of rind (fig. 3)	Yes	Yes	Yes	Yes
16. Gumming of inner tips of fruit locules (fig. 3)	No	—	Yes	Yes
17. Gumming of core, or axle, of fruit	Yes	No	Yes	Yes
18. Misshapen, hard, or dry fruit	Yes	Yes	Yes	Yes
19. Shriveled, darkened, or undeveloped seed	No	—	Yes	Yes
20. General tree resemblance to exanthema, or copper deficiency**	Yes	Yes	Yes	Yes

*Infrequently found.

**Twisting and downward drooping of vigorous shoots, and symptoms 9, 10, and 11.

form cultural treatment, which included no boron fertilization insofar as it is possible to ascertain. When first seen early in March 1949 the trees were still dormant and the Washington Navels showed rather severe distress symptoms in the foliage (only a few scattered fruits were present) that appeared identical to those in the young Valencia trees on a low-boron ration in sand cultures. About 50 to 60 percent of the leaves were affected. The principal symptoms present were: (a) yellowing along midrib and lateral veins (fig. 2, B and C), (b) veins somewhat swollen on upper surface of the leaf with occasional splitting and corking, (c) some leaves (non-chlorotic ones) thickened and somewhat brittle, (d) buckling of the leaves which throws the internal area of the leaf blade either upward or downward in relation to the margin (fig. 2, A and C), (e) some terminals rosetted as a result of shortened internodal areas of the stem, (f) dead areas of bark on some of the younger twigs and (g) a dull, lusterless appearance of the foliage in general. The youngest leaves on the trees were the most severely affected ones (about 8-month-old leaves from the 1948 summer growth cycle). Those leaves with the yellowish veins abscised soon after this condition developed, leaving areas of bare branches on the trees (fig. 3, 4). The thickened leaves (non-chlorotic) are rather persistent and do not appear to show a shortened life. The symptoms were somewhat worse on the south and southwest exposures, although they could be found on all portions of the tree.

The crop of fruit had been picked, but an occasional off-bloom fruit was present. A few of these showed a lumpy contour and gum deposits in the albedo layer of the peel (fig. 3, G and H).

Symptoms as described, although somewhat more intense, were also found in a few sour orange trees that had developed after the Navel scions had died out several years previously. There was considerable fruit on these trees, most of which was undersized, hard, dry, and mummified in appearance. Gumming was very common in the albedo, in the inner tips of the locules near the central axis of the fruit, as well as in the axis (fig. 3, C, D, E, and F). Veinal chlorosis was very prominent. Since these sour orange sprouts appear to be even more sensitive to limited boron supply than budded varieties, they may prove to be useful indicators of boron deficiency when they happen to occur in an orchard.

The Hamlins showed slight, but similar, foliage symptoms but no fruit could be found to examine. The Temple trees showed no leaf symptoms at all and were carrying a good crop of normal fruit.

The three varieties are in separate areas of the planting; but the soil is quite uniform over the entire area, which suggests that the scion variety may be an important factor in the expression of deficiency symptoms.

On March 16, a borax spray (1 lb.:100 gal.) was applied to the Navels, one row being left unsprayed for further observation. This was applied with a liquid sulfur spray. One row was sprayed with the sulfur and then borax was added for the remainder of the grove. The one row which did not receive boron is hereafter referred to as "unsprayed." The spring growth had not yet appeared, being delayed by the drought. On March 29, new growth was present in profusion on the sprayed trees but virtually absent on the unsprayed trees. A similar delay in new growth has been reported in the case of apples that were under stress for boron[3]. Only 3 terminals of new growth could be found on the 17 unsprayed Navel trees. These young leaves were unduly yellowish in color and were removed for analysis, along with a set of comparable size from an adjacent sprayed row. Although the leaves were of nearly the same size, the leaves from the sprayed trees were much greener and somewhat thicker, as is indicated by their greater dry weight (table 2). Young Valencia leaves from trees receiving low and adequate amounts of boron (about 0.001 and 0.5 p.p.m. B in the culture solutinn, respectively) in sand cultures were taken for comparison (table 2).

The unsprayed Navel trees put out a bloom and flush of leaves about 8-10 days after the sprayed trees. No discernible difference in the number of flowers was evident in relation to the spray treatment. The bloom was very heavy throughout and flowers were frequently found on completely defoliated branches (fig. 2,B), indicating that the ability to flower was not impaired by the affliction. This same observation had previously been made with the Valencias under controlled conditions. Many of the defoliated branches that flowered did not produce new leaves and failed to set fruit. A gradual dying back of these young limbs followed.

Several additional samplings of this spring-growth flush were made during the spring and summer (table 2). In each case the trees that were sprayed produced slightly larger leaves and these had more boron in them than the untreated trees. The differences are not large but tend to substantiate the visible evidence that the sprayed trees are making the most rapid recovery. The fact that considerable defoliation had taken place at the time of treatment should be taken into consideration. It seems highly probable that the effect of the spray would have been much

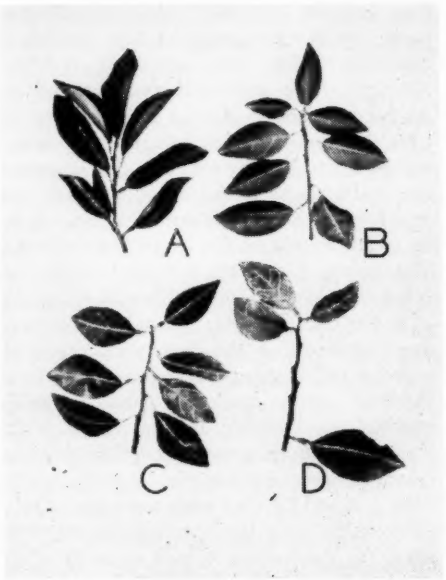

FIG. 1. Young (4-month-old) shoots of Valencia orange on Rough lemon stock (1/6 natural size; (A) Normal shoot from tree grown in sand culture with complete nutrients added; (B-D), shoots from trees grown with boron omitted from the culture solution. An early symptom of deficiency is the yellowing of midrib and lateral veins (B), followed by curling (C), accentuated veinal chlorosis, yellowing, and defoliation (D).

TABLE 2.
LEAF WEIGHT AND BORON CONTENT OF VALENCIA AND NAVEL ORANGE LEAVES OF DIFFERENT AGES AND WITH DIFFERENT BORON TREATMENTS

Variety, leaf age, and treatment	Date sampled	Mean leaf wt. mgm.	p.p.m. Boron in dry leaves	Micrograms Boron per leaf
Valencia, 1 week, low boron(a)	3-29-49	34	6	0.2
Valencia, 1 week, — boron(b)	3-29-49	35	28	1.0
Valencia, 18 weeks, low boron(a)	7-10-48	274	14	3.8
Valencia, 18 weeks, — boron(b)	7-10-48	283	140	39.3
Navel, 1 week, Unsprayed	3-29-49	50	4(d)	0.2
Navel, 1 week, Sprayed(c)	3-29-49	80	21(d)	1.7
Navel, 5 weeks, Unsprayed	4-29-49	196	12	2.4
Navel, 5 weeks, Sprayed	4-29-49	214	17	3.6
Navel, 10 weeks, Unsprayed	6-14-49	274	15	4.1
Navel, 10 weeks, Sprayed	6-14-49	297	26	7.7
Navel, 18 weeks, Unsprayed	7-29-49	294	22	6.5
Navel, 18 weeks, Sprayed	7-29-49	300	33	9.9
Navel, 1 week, Unsprayed	8-24-49	89	29	2.6
Navel, 1 week, Sprayed	8-24-49	81	37	3.0
Navel, 6 weeks, Unsprayed	9-29-49	325	24	7.8
Navel, 6 weeks, Sprayed	9-29-49	311	26	8.1
Navel, 6 weeks, Unsprayed(e)	9-29-49	318	48	15.7
Navel, 6 weeks, Sprayed(e)	9-29-49	300	47	14.1
Valencia, 18 weeks, Mean, 29 mature Florida groves			92	

(a) 2-year-old Valencia/RL in sand culture with about 0.001 p.p.m. B. Deficiency symptoms were present but affected leaves were not included in the samples.
(b) 2-year-old Valencia/RL in sand culture with about 0.50 p.p.m. B.
(c) Trees sprayed with 1 lb. borax per 100 gal. on March 16, 1949, before the appearance of these leaves.
(d) Single sample. All Valencia values are the mean of four samples; all other navels the mean of three.
(e) 3 ounces of borax applied to soil around each tree on 8-24-49.

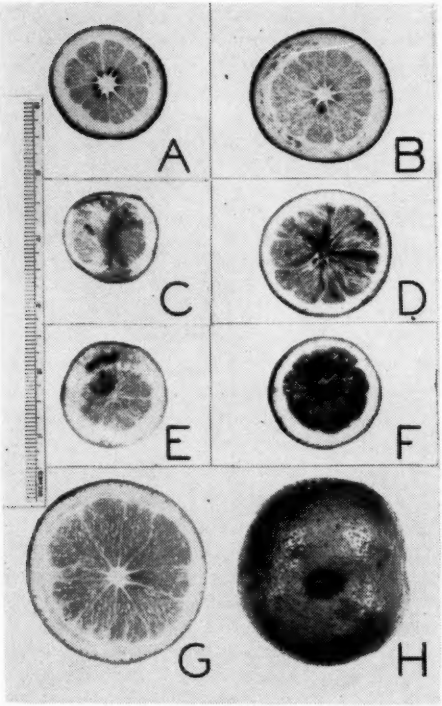

FIG. 3 Typical boron deficiency symptoms in fruits: A and B, Immature Valencia fruits from controlled sand cultures showing gum formation in the albedo and inner tips of the locules; C-F, various views of sour orange fruits from sour orange sprouts in the Navel grove. Note gumming in various portions of the fruits and the lack of seed development. A shriveled seed may be seen in C. These were mature, hardened and mummified fruits. Gumming of the albedo and lumpy contour of Navel fruits are shown in G and H.

greater if it had been applied earlier when all of the older leaves were still on the trees. About 40 to 50 percent of the leaves had fallen when the spray was applied.

All of the trees showed increased boron in the leaves with the advent of the summer rains that started in June. The content, however, was still relatively low, indicating that the trees were getting boron from the soil only in limited amounts even in the rainy season. Healthy, mature orange leaves usually show from 40 to about 200 p.p.m. of boron[11]. By way of comparison, the mature Valencia leaves on low boron ration showed an average of 14 p.p.m. total boron and showed strong deficiency symptoms.

As the spring-flush leaves developed on the unsprayed trees, mild boron deficiency symptoms appeared (b, c, d, and e as listed in text). They were entirely absent on the comparable leaves of the sprayed Navel trees.

The main summer-flush of growth occurred in mid-August. No deficiency symptoms were found in the very young leaves, and they had (table 2) what would appear to be a normal amount of boron for week-old leaves. There was still some effect of the March spray treatment as the leaves from these trees showed over 25% more boron (compare 29 and 37 p.p.m. boron). These leaves appeared during the period of adequate moisture supply and differ sharply from leaves of a similar age from the same trees taken in March under drought conditions. The respective boron concentrations at that time were 4 and 21 p.p.m. This substantiates the evidence with other types of plants that soil moisture influences boron availibility.

The native boron supplying power of the soil in this particular grove is relatively low as shown by the following test. On August 24 three ounces of borax (18% B_2O_3) per tree was applied to the soil around each of five trees of the 17 unsprayed trees and to a like number of trees that had received the original boron spray. A hurricane, which occurred during the next few days, brought about four inches of rainfall. Five weeks later (September 29) the tree response was such that the treated trees were pointed out by an observer who did not know which trees had been given the soil application. A deeper green color and longer shoot growth served to distinguish the trees that had received the three ounces of borax from those that did not. Many of the six-week-old leaves on the trees that did not receive the three ounces of borax showed a whitish-yellow color of the midrib and a general off-green color. These symptoms of mild boron deficiency were present on both unsprayed and sprayed trees. The leaves of these two treatments were also nearly identical in their boron content (compare 24 and 26

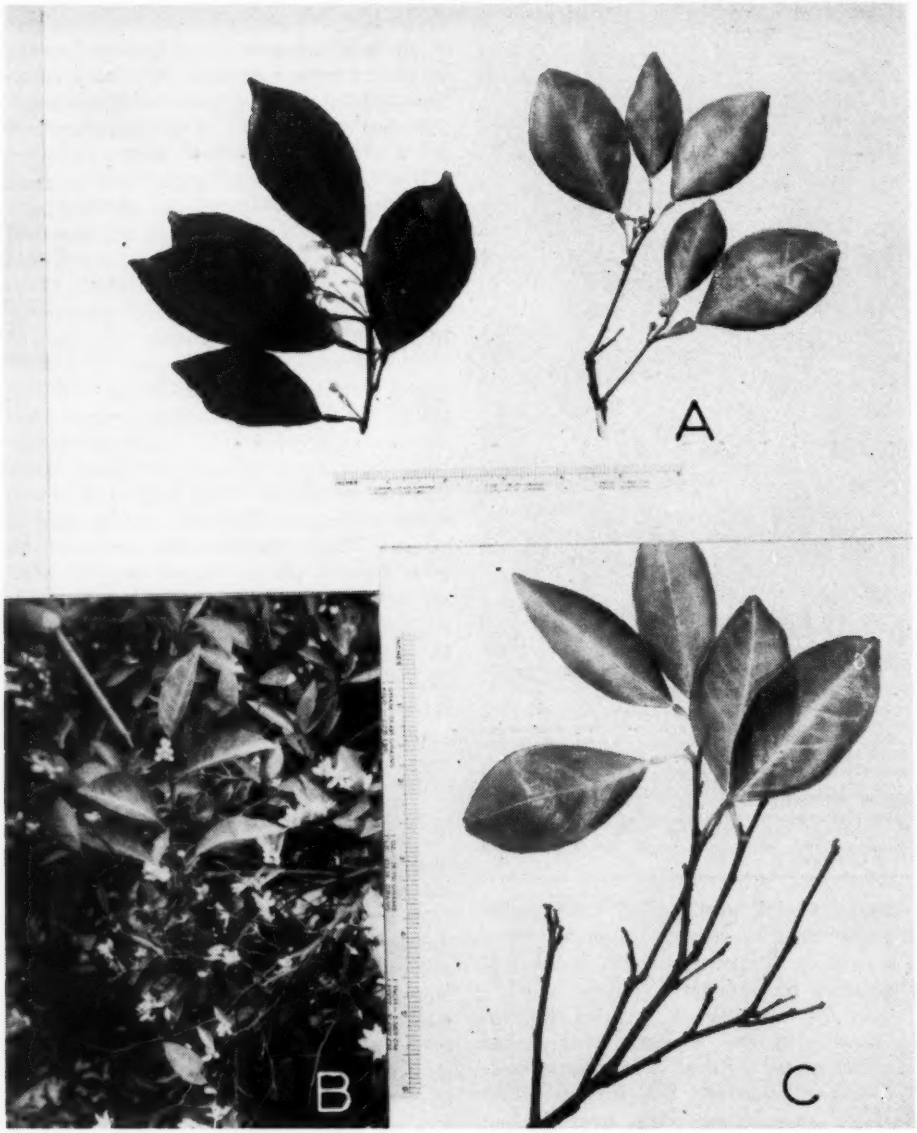

FIG. 2. Typical foliage, twig and flower condition as seen in early April 1949 in Washington Navel orange grove growing on sour orange stock near Eustis, Florida. Note veinal chlorosis in B and C and curling of leaves in A (right) and C. Defoliation is evident in B and C with flowers on the defoliated branches in B. The twig on the left in A is one that appeared to be normal.

p.p.m. for 9-29-49 in table 2). The leaves of a similar age from the trees which received the soil applications showed about 48 p.p.m. boron, and here again no difference was induced by the spray application of the previous March. The values of 24 and 26 p.p.m. are somewhat low for a nearly mature leaf. The better appearance of the trees as a result of the ground application suggests that even with abundant soil moisture the trees were limited in growth by the lack of adequate boron from the untreated soil.

Despite the poor condition of the foliage at the time of bloom and the relatively light set of fruit, it appeared that somewhat more fruit was set on the sprayed trees. To measure this response, counts were made of the fruit on each of ten sprayed trees and a like number of unsprayed trees on September 23, 1949. The sprayed trees averaged 277 fruits and the unsprayed 214 per tree. This difference of about 30 percent is suggestive that the spray treatment either enhanced the set of fruit or retarded subsequent droppage. Recent work[2] in Washington indicates that the set of pear fruit was increased by application of boron spray during the bloom period.

To summarize, it seems highly probable that boron deficiency occasionally exists in Florida citrus groves. The appearance of all of the listed (table 1) foliage and fruit symptoms in the Washington Navel orange trees on sour orange stock, together with the low boron content of leaves and the response to boron applications, leave little doubt of positive identification of boron deficiency in this one grove.

It is felt that a better appreciation of the various foliar symptoms that have not previously been associated with boron deficiency in the field, would be useful to growers in detecting early cases, and these could be quickly remedied by the insertion of boron in one of the dormant or (and) post-bloom spray applications. This is especially useful during periods of prolonged drought or in the absence of irrigation; otherwise soil applications should give a quick response under acid soil conditions. Dependence on fruit symptoms for diagnosis would probably result in a lightened crop, as it would then be too late for corrective measures that would influence the crop already on the trees.

The earliest symptoms noted, both in the sand cultures and the field, was the yellowing along the midrib and lateral veins. This symptoms developed quickly—in a matter of days—and defoliation of such twigs soon followed. The thickened, buckled type of leaf is slower to develop and of longer pesistence on the tree. The enlargement of the veins is also a gradual process. Periods of drought accentuate the expression of boron defiency symptoms.

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A COMPARISON OF THE MINERAL COMPOSITION OF VALENCIA ORANGE LEAVES FROM THE MAJOR PRODUCING AREAS OF THE UNITED STATES

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Very little is known concerning the comparative mineral composition of citrus foliage, especially trace element composition, in the several producing regions of the United States. The incomplete data available from various sources[1,2,7,9] make strict comparisons difficult because of variations in sampling methods, age of leaves, and other factors. The data considered in this report were obtained with a view to obtaining additional background information of value in establishing the relation between leaf composition and vigor and fruiting behavior of citrus plantings. Analyses for 11 elements were made on foliage samples collected in 1947 and 1948 from commercial Valencia orchards. This is a major orange variety in all citrus growing regions of the United States.

METHODS

Most of the Florida samples were obtained in orchards on the acid, very sandy soils of the central part of the state. No samples were collected from groves located in the more fertile but less perfectly drained soils of the coastal citrus regions. Usually 3 leaf samples, consisting of 36 leaves each, were collected in each grove or portion of a grove sampled. One median leaf was harvested from each of six non-fruiting, spring-flush shoots distributed around each tree in a zone 3 to 7 feet from the ground level. Shoots supporting summer-flush leaves were avoided. Six trees in a compact group were used for each sample.

The western samples were obtained in a similar manner, except that only one sample was obtained from each planting in most cases, and this consisted of about 100 leaves, usually composited from about 10 trees. The samples were washed, dried, and analyzed for the major nutrients in a manner described elsewhere[10]. The trace elements and sodium were determined by spectographic means using a D. C. arc, complete burning and comparison standard technique[6]. Zinc was determined by the A. O. A. C. method[1].

EXPERIMENTAL RESULTS

The Valencia orchards represented in table 1 were, with a few exceptions, mature, bearing blocks which produced satisfactory to very good crops in the three years immediately preceding sampling. It is felt that these represent a rough cross-section of mature commercial groves in the sandy soils in the central part of the state in which an effort was made to maintain a high level of productivity. They include a wide variety of fertilizer and other cultural practices. Almost all were on Rough lemon stock.

The plantings represented by the California samples in table 2 are from a wide range of climatic and soil conditions, but of course are not numerous enough to be considered a cross-section of California conditions. Nevertheless, the ranges of major nutrients found by Chapman[4] in "high performance orchards" do not differ widely from those found by us in this very limited sampling. Likewise, the samples obtained in Arizona and Texas are limited in number, but we believe that they were selected in a manner which should portray at least a rough indication of the mineral status of the foliage of Valencia oranges in those regions.

The samples obtained in the Phoenix area of Arizona were from trees that had been more or less damaged by a freeze which occurred on February 13, 1948. Orchards which had been severely damaged were avoided, but samples were obtained from some orchards which had been partially defoliated by this freeze.

Table 1. Analysis of Valencia orange foliage from central Florida orchards.

Orchard No.	Location near	Root-stock	Soil type	Date of sampling	Est. age of leaf, mo.	Mean dry wt. per leaf, mgm.	Major foliage constituents, mean[1] percent in dry matter						Trace elements, mean[1] p.p.m. in dry matter				
							N	P	K	Ca	Mg	Na	Zn	Cu	Fe	Mn	B
1	Clearwater	R.L.	Lakeland f.s.	8/6/47	4	319	2.69	0.148	1.97	2.88	0.435	0.091	24	25*	68	39	57
2	"	"	"	"	4	297	2.83	0.133	1.37	3.60	0.446	0.091	22	17*	66	38	70
3	"	"	"	"	4	313	2.76	0.137	1.31	3.38	0.469	0.084	24	7.0	63	34	61
4	"	"	"	"	4	336	3.00	0.127	1.54	3.57	0.500	0.061	21	6.3	60	30	73
5	"	"	"	"	4	307	2.74	0.134	1.48	3.81	0.494	0.046	17	6.5	51	29	85
6	"	"	"	"	4	284	2.72	0.131	1.31	2.98	0.414	0.051	24	8.0	52	27	65
7	"	"	"	"	4	281	2.81	0.144	2.08	2.99	0.341	0.039	29	20*	54	41	77
8	"	"	"	"	4	279	2.66	0.142	1.79	2.76	0.426	0.043	30	31*	52	31	77
9	Dunedin	"	"	8/5/47	4	277	2.74	0.137	1.58	3.15	0.413	0.046	24	9.4	61	39	152
9a	"	"	"	"	4	282	2.60	0.130	1.84	2.82	0.440	-	-	-	-	-	-
10	Plymouth	"	"	8/13/47	4½	267	2.84	0.142	1.79	2.76	0.426	0.043	46*	31*	52	31	77
11	"	"	"	"	4½	277	2.83	0.138	1.32	3.25	0.333	0.052	20	9.2	67	68	86
12	"	"	"	"	4½	303	2.73	0.151	1.42	3.14	0.354	0.040	>100*	55*	76	41	159
13	"	"	"	"	4½	272	2.68	0.153	1.77	2.75	0.388	0.064	>100*	56*	82	43	88
13a	"	"	"	"	4½	279	2.87	0.159	2.20	2.66	0.368	0.046	>100*	64*	73	38	141
14	"	"	"	"	4½	281	2.56	0.147	1.13	3.94	0.428	0.037	18	6.8	55	40	212
15	"	"	"	"	4½	232	2.55	0.141	1.18	3.82	0.377	0.045	26	33*	57	65	185
16	"	"	"	"	4½	304	2.63	0.141	1.23	3.13	0.430	0.044	23	5.6	75	37	305
17	"	"	"	"	4½	310	2.81	0.148	1.35	3.00	0.428	0.042	17	6.1	92	43	151
18	"	"	"	"	4½	281	2.80	0.150	1.33	3.74	0.439	0.038	20	8.8	72	46	120
19	Clermont	"	"	8/27/47	5	321	2.28	0.133	2.15	2.71	0.409	-	-	-	-	-	-
20	Tavares	"	"	7/30/47	4	308	2.74	0.141	1.98	2.44	0.510	0.050	20	5.3	102	85	80
20a	"	S.O.	"	"	4	270	2.56	0.135	2.14	2.32	0.472	0.047	17	5.2	71	67	69
21	Waverly	R.L.	"	8/14/47	4½	231	2.94	0.151	1.48	4.43	0.364	0.066	19	9.5	60	34	38
22	"	"	"	"	4½	246	2.83	0.156	1.89	3.42	0.354	0.046	22	9.9	71	22	46
23	"	"	"	"	4½	265	2.83	0.151	1.78	3.53	0.329	0.049	24	10.2	64	28	48
24	"	"	"	"	4½	277	2.83	0.139	1.60	3.84	0.328	0.054	19	7.7	49	22	53
25	"	"	"	"	4½	279	2.80	0.143	1.41	3.08	0.303	0.044	16	5.0	75	20	33
26	"	"	"	"	4½	289	2.88	0.141	1.64	2.80	0.334	0.041	25	39*	72	31	45
27	Winter Haven	S.O.	Blanton f.s.	"	4½	313	2.56	0.132	1.40	4.24	0.326	0.041	18	9.1	42	27	45
27a	"	R.L.	"	"	4½	289	2.71	0.136	1.24	4.05	0.327	0.045	16	8.5	45	31	59
28	Dade City	S.O.	Hernando s.l.	8/2/48	5½	271	2.18	0.111	0.95	5.50	0.359	0.036	-	6.2	36	25	46
29	"	"	"	"	5½	234	2.25	0.118	1.07	5.15	0.400	0.040	-	6.3	43	25	41
30	"	R.L.	Gainesville s.l.	"	5½	306	2.40	0.118	1.57	4.26	0.300	0.038	-	5.0	39	30	67
31	"	Cleo	"	"	5½	279	2.38	0.118	1.39	4.13	0.330	0.035	-	6.2	46	28	66
32	"	R.L.	Lakeland f.s.	"	5½	275	2.40	0.142	1.39	3.0	0.293	0.041	-	6.4	57	20	80
33	"	"	"	"	5½	298	2.15	0.129	1.53	4.15	0.340	0.047	-	5.4	48	32	160

*These high values probably due to incomplete removal of Zn and Cu spray residues from leaves

1/ Usually the mean of 3 samples taken from each orchard, and analyzed separately

NOTES:

Orchards 1, 2, 3, and 4 irrigated with salty well water

Orchards 6a is the same as 6, but supplementary K and Mg added to fertilizer

Orchard 13a is the same as 13, but supplementary KCl added to fertilizer

Orchards 19, 20, and 20a young trees, 5 to 6 years old

Orchards 21, 24, 25, 26, and 32 show slight to moderate magnesium deficiency symptoms

Orchards 21 and 25 show slight zinc deficiency symptoms

Orchards 25 and 32 show slight manganese deficiency symptoms

Orchards 22, 23, 27, and 31 have history of unsatisfactory production.

Table 2. Analysis of Valencia orange foliage from California, Arizona, and Texas orchards.

Orchard No.	Location, near	Root-stock	Soil type	Date of sampling	Est. age of leaf, mo.	Mean dry wt. per leaf, mgm.	Major foliage constituents, percent in dry matter						Trace elements, p.p.m. in dry matter				
							N	P	K	Ca	Mg	Na	Zn	Cu	Fe	Mn	B
California																	
1	Los Angeles	R.L.	Yolo cl.l.	6/16/48	2½	203	2.75	0.158	0.54	2.69	0.214	0.026	18	6.5	38	9.8	70
1a	"	S.O.	"	"	2½	252	2.20	0.127	0.65	3.82	0.180	0.024	18	6.9	44	9.9	67
2	Riverside	R.L.	Ramona s.l.	6/14/48	2½	203	2.75	0.158	0.35	3.00	0.328	0.024	33	10.0	47	15.0	41
2a	"	S.O.	"	"	2½	252	2.20	0.129	0.48	3.62	0.261	0.022	21	6.8	39	12.0	30
3	"	"	Ramona l.	"	2½	216	2.48	0.115	0.31	4.40	0.271	0.027	18	5.1	36	12.0	33
4	Indio	"	Coachella f.s.	6/12/48	3	306	2.62	0.132	0.46	3.68	0.271	0.020	12	7.6	70	15.0	60
5	"	"	"	"	3	272	2.20	0.143	1.25	4.36	0.271	0.020	8	7.9	64	17.0	60
6	"	"	Indio sl.l.	"	3	262	2.75	0.129	0.43	4.80	0.285	0.022	18	7.6	41	15.0	62
7	Bard	R.L.	Holtville? sl.l.	6/8/48	3	206	1.92	0.137	1.53	4.70	0.285	0.022	16	10.1	30	10.2	87
8	"	S.O.	"	"	3	168	2.35	0.165	1.05	4.44	0.285	0.027	-	9.2	45	8.7	64
Arizona																	
1	Yuma	R.L.	Superstition s.	6/8/48	3	249	2.02	0.143	1.48	4.22	0.306	0.026	25	8.2	44	14.0	80
1a	"	S.O.	"	"	3	232	1.82	0.151	1.65	2.76	0.418	0.025	15	5.4	36	7.1	67
2	"	S.O.	"	"	3	226	1.92	0.158	1.48	5.10	0.410	0.022	18	7.8	41	8.6	64
3	"	R.L.	"	"	3	236	1.82	0.160	1.13	5.10	0.381	0.028	16	8.4	33	11.0	77
3a	"	S.O.	"	"	3	235	1.82	0.151	1.18	5.10	0.332	0.022	13	6.6	37	7.2	57
4	Sacaton	"	? sl.l.	6/9/48	2½	231	2.22	0.115	1.10	4.30	0.285	0.021	10	10.0	31	8.7	294
4a	"	"	? sl.l.	"	2½	230	2.20	0.136	1.13	4.55	0.313	0.021	8	9.4	35	10.2	265
5*	Phoenix	R.L.	Mohave l.	6/10/48	2½	180	2.30	0.158	1.10	4.36	0.285	0.023	17	10.2	18	8.5	47
5a	"	"	"	"	2½	207	2.40	0.165	0.98	3.75	0.285	0.055	18	10.0	34	14.0	89
6	"	S.O.	"	"	2½	221	1.90	0.132	1.21	4.56	0.362	0.025	13	10.0	30	7.6	69
7	"	R.L.	Cajon l.	"	2½	179	2.20	0.143	0.72	2.95	0.264	0.020	13	9.6	33	14.0	50
7a	"	S.O.	"	"	2½	201	2.25	0.143	1.10	2.38	0.334	0.034	17	10.4	46	22.0	70
8	"	R.L.	Mohave st.l.	"	2½	164	2.68	0.125	1.23	3.35	0.313	0.144	16	10.5	47	23.0	96
9	"	"	"	"	2½	186	2.30	0.132	1.25	4.00	0.285	0.038	18	10.1	35	34.0	77
10	"	S.O.	Mohave s.l.	"	2½	195	2.30	0.147	0.98	4.72	0.389	0.045	18	11.4	41	10.2	128
11	"	"	Mohave st.l.	"	2½	273	2.20	0.140	1.58	5.40	0.540	0.021	12	5.6	39	8.9	220
12	"	"	"	"	2½	218	2.30	0.158	1.43	5.40	0.368	0.023	16	8.9	29	9.3	79
Texas																	
1	Rio Farms	S.O.	Willacy f.s.l.	6/29/48	3½	357	2.50	0.110	0.87	5.44	0.334	0.057	26	7.0	82	28.0	89
1a*	"	"	"	"	3½	292	2.58	0.125	1.58	4.76	0.271	0.049	26	9.5	40	11.6	131
2**	"	"	"	"	3½	196	2.50	0.147	0.72	4.90	0.355	0.056	22	6.7	53	22.0	62
3	Elsa	"	"	"	3½	263	2.30	0.115	0.46	5.54	0.306	0.123	20	10.0	64	24.0	194
4**	"	"	"	"	3½	181	2.40	0.147	0.72	4.00	0.320	0.079	26	8.1	78	27.0	239
5	McAllen	"	Brennan f.s.l.	"	3½	232	2.40	0.118	0.46	3.28	0.293	0.034	20	8.6	62	21.0	125
6	Las Fresnas	"	Hidalgo f.s.l.	6/28/48	3½	271	2.40	0.111	0.57	5.90	0.299	0.169	22	9.9	105	29.0	55
7**	"	"	? f.s.l.	"	3½	256	2.12	0.111	0.61	5.20	0.355	0.171	24	9.8	77	32.0	118
8	"	"	?(resaca) f.s.l.	"	3½	270	2.02	0.100	1.18	5.70	0.316	0.105	24	10.4	57	31.0	80
9**	Harlingen	"	? f.s.l.	"	3½	221	2.02	0.121	0.65	5.60	0.334	0.094	18	11.0	74	48.0	91
10	Weslaco	"	Hidalgo f.s.l.	"	3½	275	2.30	0.118	1.08	5.80	0.264	0.046	19	10.6	71	30.0	111

*Chlorotic leaves

**Low vigor orchards associated with poor drainage and salinity.

Comparisons of the summarized data in table 3 suggest that the Florida leaves are in general heavier than those from the western citrus regions, but that large leaves may be found in all regions. In the orchards sampled, the nitrogen level was generally higher in Florida than in the West. The very low level of nitrogen reflected by the Arizona samples is probably due in part to the practice in the Yuma area of applying nitrogen in the fall and winter months only, and inducing a low nitrogen level in summer and winter to improve fruit quality by growing non-legume crops. The samples from the Phoenix area, though somewhat higher in nitrogen than those from Yuma, are perhaps lower than normal because of the reluctance of some growers to purchase fertilizers for spring application in the face of loss of revenue resulting from frost damage to a large portion of the 1948 Valencia crop, and reduced prospects for the 1949 crop. The very high level in Florida may be in part a reflection of the predominance of Rough lemon rootstock in that region.

A very striking contrast in foliage composition occurs in the case of calcium and potassium. The average percentage of calcium in the Texas samples was about 50 percent greater than that found in the Florida samples. The calcium content of California and Arizona samples occupied an intermediate position. If these leaves had been harvested a month or so later, they would have been more nearly comparable in age to the Florida samples, and it is probable that the levels found would have been closer to those found in Texas and to the range found in California by Chapman (table 3). As fully developed leaves become older, the calcium concentration increases, and potassium decreases[16]. No doubt the high calcium level in leaves is a reflection of the calcareous nature of many of the western citrus soils. This relatively high calcium concentration in the soil probably accounts in part for the relatively low potassium content found in the samples from Texas and California, which amounted to only about one-half the level found in the Florida samples. Foliage samples from Arizona contained an intermediate concentration of potassium. Again, the levels in the western samples would have been somewhat lower if the samples had been collected a month or so later.

Table 3. Summary of analyses of Valencia orange foliage from Florida, Texas, Arizona, and California orchards

Region and no. samples	Age of leaves, mo.	Range	Mean dry wt. per leaf, mgm.	Major foliage constituents, percent in dry matter						Trace elements, p.p.m. in dry matter				
				N	P	K	Ca	Mg	Na	Zn	Cu	Fe	Mn	B
Central Florida 37 locations	4 to 5½	Max.	336	3.00	0.159	2.20	5.50	0.510	0.091	30	10.2	102	85	305
		Min.	231	2.15	0.111	0.95	2.32	0.293	0.035	16	5.0	36	20	33
		Mean	285	2.66	0.139	1.56	3.44	0.390	0.049	21	7.2	61	37	92
Texas, 11 locations	3½	Max.	357	2.50	0.147	1.18	5.90	0.355	0.171	26	11.0	105	48	239
		Min.	181	2.02	0.100	0.46	3.28	0.264	0.034	18	6.7	40	11.6	55
		Mean	252	2.30	0.120	0.73	5.14	0.318	0.089	22	9.2	69	28	118
Arizona, 17 locations	2½ to 3	Max.	273	2.68	0.165	1.65	5.40	0.640	0.144	25	11.4	47	34	294
		Min.	164	1.82	0.115	0.72	2.38	0.264	0.021	8	5.4	18	7.1	47
		Mean	216	2.16	0.145	1.22	4.24	0.351	0.035	15	9.0	36	12.8	108
California, 10 locations	2½ to 3	Max.	306	2.75	0.165	1.53	4.80	0.328	0.027	33	10.1	64	17	87
		Min.	168	1.92	0.115	0.31	2.69	0.180	0.020	8	5.1	30	8.7	30
		Mean	234	2.42	0.140	0.71	3.95	0.265	0.023	18	7.8	45	12.5	57
California, Chapman data[1]	3 to 7	Max.	-	3.16	0.182	1.12	5.52	0.40	0.10	80	10	200	80	100
		Min.	-	2.00	0.092	0.38	3.00	0.20	0.02	20	4	70	20	20
		Mean	-	2.45	0.130	0.71	4.70	0.30	0.06	30	7	120	30	30

1/ From data of Chapman (4) obtained from "high performance orchards."

*Chlorotic leaves
**Low vigor orchards associated with poor drainage and salinity.

There is very little difference in the range of phosphorus concentration in leaves from the four regions studied, although Texas samples average a little lower. The magnesium levels in leaf samples in Florida, Arizona, and Texas are somewhat higher than those from California. Some in California are near the critical level suggested by Chapman[1]. Whether the relatively high levels found in a few Florida and Arizona samples are desirable or not remains to be determined by future studies.

The sodium concentration in citrus leaves is not high. In Florida, samples which had more than 0.07% were obtained from orchards which had been irrigated with water from salty wells. In Texas, samples having values near the upper range of sodium concentration were in most cases, but not all, from low vigor orchards located in poorly drained, saline soils. The low sodium level prevailing in the California samples is probably another reflection of the repressive effects of a high calcium concentration on the uptake of other bases in non-saline soils.

Some rather striking differences among the several regions are indicated by the trace element data obtained. In the case of the copper content of the Florida samples, the results divide themselves into two groups—those that contain between 5 and 10 p.p.m. (25 samples) and those that contain between 17 and 64 p.p.m. (10 samples). Because of the probability of incomplete removal of copper spray residues by the washing technique used, the values in this latter group are suspected of being too high because of this surface contamination[17], and were not included in the range presented in table 3. Thus it seems reasonable to postulate that if methods could be devised to effectively remove copper spray residues from leaves, analysis would indicate about the same range of copper content in all the citrus regions. No copper deficiency symptoms were noted in any of the orchards sampled in any of the regions.

The iron values presented are lower than those found by Chapman[4,5] and by others[8]. This is probably due to the efficacy of the washing technique used in this study in removing surface iron contamination[17]. Arizona sample number 5 was obtained from trees at the lower end of an irrigation run which were decidedly chlorotic, apparently due to over-irrigation. These leaves had only 18 p.p.m. of iron, while leaves from unaffected trees near the middle of the irrigation run in the same orchard (sample 5a) had 34 p.p.m. of iron. All the samples in Arizona and most in California are below the critical iron level suggested by Chapman, while most in Florida and Texas are above.

In central Florida manganese salts are regularly applied in mixed fertilizers to most mature citrus plantings at a rate between 20 and 30 pounds of MnO per acre per year. The use of manganese salts as a soil treatment in western orchards is not a common commercial practice, but manganese nutritional sprays are used to some extent, particularly in California. So far as we were able to determine, none of the western orchards sampled had been recently sprayed with manganese. The data indicates that there was on the average about twice as much manganese in the Florida orchards sampled as in those of Arizona and California. The Texas orchards sampled had an intermediate level of manganese. The lowest manganese content found in a Texas sample (1a) was from a portion of an orchard affected with chlorosis, but the symptoms were not those commonly associated with manganese deficiency[8], but rather those associated with "iron chlorosis"[8]. No typical symptoms of manganese deficiency were noted in any of the western orchards sampled, but two Florida orchards (25 and 32) showed typical symptoms. These had the lowest manganese levels (20 p.p.m) among the Florida samples, but were much higher than most California and Arizona samples which showed none. The critical level suggested by Chapmas is 15 p.p.m.

The boron level in the orchards surveyed varied through a wide range. A few in Texas and Arizona and two in Florida were somewhat above the excessive level of 200 p.p.m. suggested by Chapman. Just what damage to tree vigor and fruitfulness is associated

with boron levels of 200 to 400 p.p.m. has not yet been determined with certainty. While some of the boron levels in Florida and California were somewhat low, none was so low as to be in the range usually associated with definite symptoms of boron deficiency[4, 5].

The zinc data obtained indicates that the level of this element in many of the orchards surveyed, particularly in Arizona, was near or below the deficiency value of 15 p.p.m. suggested by Chapman[4]. In the Florida samples, some high zinc values were not included in the range presented in table 3, because it was suspected that these, like the high Cu values, were due to incomplete removal of spray residue from the leaves.

Discussion

With most deciduous fruit plants, a level of potassium nutrition reflected by 1.0 to 1.5 percent or more of potassium in 3 or 4-month-old leaves is associated with satisfactory productivity and vigor. Below this level, vigor and productivity is likely to be suboptimal[8]. These criteria are based primarily on field experiments conducted in the predominantly acid fruit soils of humid regions. The published data available relating leaf composition to yield and growth in well designed field fertilizer experiments are less extensive for citrus than for deciduous friuts. Haas[9], working in California, found symptoms of potassium deficiency in sand cultures and commercial citrus orchards associated with a potassium concentration in leaves below about 0.35 percent. Similar observations were made by Arnot[2] in Australia, but the symptoms described differed somewhat. Chapman[4] tentatively concluded from greenhouse and field studies in California that 3 to 7-month-old orange leaves containing less than 0.4 percent of potassium probably indicated potassium deficiency, but that it was rather doubtful if response to potassium would be obtained in orchards with values higher than 0.4 percent. He found that the "high performance orchards" surveyed had potassium levels ranging between 0.38 and 1.12 percent.

In summarizing field fertilizer studies that were carried out over a period of years on various soil types in California orange orchards, Parker and Batchelor[12] concluded that applied potassium was of no value in improving yield or fruit quality. No potassium analysis of leaves are presented, but they state that some analyses were made which indicated that potassium fertilization did increase the uptake by the tree. Working with Marsh grapefruit on the deep, sandy soil of the Yuma Mesa of Arizona, Finch and McGeorge[7] concluded that potassium fertilization alone or in combination with other nutrients did not affect fruiting behavior. However, the leaf analyses presented indicated that the potassium level was relatively high in all treatments. It ranged between 2 and 4 percent in dry matter in spring-flush leaves harvested in June.

The studies of Bahrt and Roy[3] in Florida indicated that reduced yield and small fruit sizes resulting from omitting potash from the fertilizer for a number of years in a Florida orange grove was associated with a level of 0.87 percent of potassium in the leaves, while all plots receiving potash in the fertilizer had a level of leaf potassium of 1.26 percent or more. However, the age of leaf sampled is not indicated but the associated calcium values suggest they were about 1 year old, judging by studies made on similar acid, sandy soils[10]. Thus the level in both treatments probably would have been somewhat higher had younger leaves been sampled. In Jamaica, Innes[10] concluded from analysis of leaves from field fertilizer plots with grapefruit that about 1.16 percent of potassium in leaves is the minimum adequate level for satisfactory production. Again, details concerning age of leaf sampled are lacking. Reporting one season's results with field fertilizer trials in Florida, Reuther and Smith[13] noted that a moderate increase in orange yield and fruit size was produced by increasing the level of potash fertilization. This was associated with a range of potassium in 4-month-old spring-flush leaves well above 1 percent.

Thus the data available tend to agree that when the potassium level in citrus leaves falls below 0.4 percent, deficiency symptoms are

likely to occur. However, there is little agreement as to where the critical level of potassium concentration in citrus leaves is, from the standpoint of economic fruit production. The California workers suggest far lower critical levels than are indicated by the scant data available from Florida and Jamaica. The absence of a well-defined leaf symptom with citrus, such as leaf-scorch of deciduous fruits, unless potassium deficiency is acute, has probably contributed to the confusion. The data in this report suggest that either the potassium levels in Florida orchards are maintained unnecessarily high, or that the prevailing potassium levels in California and Texas are too low, unless it is assumed that potassium requirements interact with soil and climatic factors. Of course, the data also suggest an inverse situation regarding the calcium levels. It is possible that subsequent research may show that a lower level of potassium nutrition is adequate to maintain high yield and satisfactory fruit size when the level of calcium nutrition, for example, is high, or when the climate is semi-arid instead of humid, but the majority of the scant evidence now available with tree crops does not suggest that such interactions occur to any marked degree. It seems to us that a more likely hypothesis is that some factor related to high soil calcium, possibly low availability of heavy metals such as iron, manganese, and zinc, or even some factor unrelated to soil calcium, is limiting yield. If this unknown factor could be isolated and corrected, then a potassium response in the form of increased yield and fruit size might be obtained in most western citrus orchards having a relatively low level of potassium in leaves.

Slight symptoms of manganese deficiency were observed in Florida orchards with magnesium levels of about 0.3% or even above (table 1), while Chapman suggests that symptoms are not likely to occur above 0.2 percent. Indeed, some California samples were obtained from trees showing no readily recognizable symptoms, yet having magnesium levels of about 0.2 or even below (table 2). It is possible that the levels of calcium and potassium (or even other less obvious minerals) in leaves interact with magnesium level from the standpoint of symptom expression. In other words, it is possible that with the pattern of calcium and potassium composition of leaves prevailing in California, magnesium may fall much lower before typical magnesium deficiency symptoms are expressed than is the case with the calcium-potassium status of leaves prevailing in Florida orchards. However, it should not be assumed that significant reductions in vigor and yield do not occur without symptom expression[11,12]. The fact that the manganese level may be far lower in California and Arizona orchards without the expression of serious deficiency symptoms on leaves may also result from similar interactions with the pattern of mineral nutrition indicated by leaf composition Of course, it is possible also that other factors, such as climate, may interact with symptom expression. In the case of the trace elements, improvements in preparation and analytical technique to reduce contamination and error may resolve some of the apparent discrepancies in the levels associated with the expression of deficiency symptoms.

These speculations concerning the possible explanations of apparent discrepancies in level of nutrients at which symptom expression or yield reduction may occur, emphasize that the objectives of future research, in our opinion, should be the determination of levels and patterns of nutrients in leaves associated with a wide range of vigor and productivity, so that relationships to growth and fruiting behavior, in addition to symptom expression, may be established. To achieve these objectives, it will be necessary to undertake critical field and sand culture studies, using experimental designs which will permit the evaluation of possible interactions between nutrient factors, as well as major effects.

Summary

In the summers of 1947 and 1948 samples were collected of 2½ to 5-month-old spring-cycle leaves from Valencia orange orchards in Florida, Texas, Arizona, and California. These were analyzed for eleven major and trace

nutrient elements. Comparison of the data obtained indicates that higher nitrogen, potassium, magnesium, manganese, and iron concentrations and lower calcium and copper were found in Florida samples than in those from other regions. Potassium was lowest in Texas and California, while calcium, sodium, zinc, and boron were highest in Texas. Nitrogen was lowest in Arizona. Phosphorus level did not vary widely among the several regions. Iron and manganese and zinc were lowest in California and Arizona. The possible significance of the wide difference in potassium and calcium and certain trace elements in leaves from Florida orchards and those from the western orchards is discussed. It is suggested that in the case of western citrus orchards having a relatively low level of postassium in leaves, failure to obtain response to potassium fertilization is due to some other as yet unidentified factor limiting productivity.

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PROGRESS REPORT ON CITRUS DECLINE

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Previous to 1945, any tree showing a poor growth or dying was classified as having decline. Thus citrus decline assumed the role of a specific disease although no actual cause was indicated. In 1947, a preliminary report indicated at least 10 common conditions or diseases which were causing decline in different groves. Since that time "decline" has been used in a general sense to refer to the condition of the tree without indicating any particular disease.

Additional data on the overall decline problem have been obtained during the past two years, and form the basis of this report. Two of the diseases in the decline complex are treated in particular—root rot and spreading decline. With regard to the former, no specific experimental work has been carried on, but sufficient information has been obtained to indicate various factors that influence the

occurrence of this disease. Spreading decline has received major emphasis, and the results of the different phases of the work to date are given here.

Prevalence of Decline

The survey to determine the relative prevalence of the various types of decline throughout the state has been continued. As of November 1, 1949, a total of 387 groves has been examined to determine the cause of the decline. As shown in Table 1 spreading decline, root rot, foot rot and water damage were the four most important causes. One of these four types was present in 81 percent of the groves examined. Of the four, foot rot is well known and can be controlled by recognized methods. Water damage is a result of weather and soil conditions, and as such is beyond easy means of control. Root rot and spreading decline are comparatively new and most of this report concerns these two diseases.

TABLE 1.
CAUSES OF DECLINE AND THEIR OCCURRENCE IN CITRUS GROVES EXAMINED

Cause of Decline	No. of Groves
Spreading Decline	93
Root Rot	87
Foot Rot	82
Water Damage	51
Psorosis	23
Lightning Injury	13
Nutritional Deficiency	12
Heart Rot	11
Algal Disease	9
Drought Injury	6
Total	387

Root Rot

The root rot condition that develops in citrus trees appears to be initiated in the fibrous roots and gradually progresses to larger roots towards the trunk of the tree. When sufficient roots have become diseased the top of the tree will begin to show decline. This may require two or three years or less than one year depending on the severity of the root rot. Eventually the branches will die back and the center of the tree will develop numerous water sprouts showing various types of deficiency symptoms in the foliage. When root-rot-infected trees are pulled the crown and tap roots are usually normal and no large number of diseased roots can be observed—a consequence of the diseased roots breaking off and remaining in the soil. The specific fungus or fungi involved in the production of the root rot have not been determined but *Physalospora rodina* (Bert. and Curt.) Cooke (*Diplodia natalensis* Evans) is usually found in the diseased roots. This fungus is not considered to be a vigorous pathogen and observations of root rot occurence in the various groves indicate that the infected trees have usually been weakened by adverse conditions before the root rot developed.

There are a number of factors that have been observed to influence the prevalence of root rot. When growing under such conditions, the trees become predisposed to infection and root rot can readily develop.

1. *Water Relations.*—Trees growing under conditions of extreme variation in the water level in the soil, and those where a constant water level is present within two or three feet of the surface will have a certain proportion of the roots injured at different times during the year. Such roots can readily be infected by the fungi that cause root rot.

2. *Age of Tree.*—A young tree may make satisfactory growth in the same location where later it falls prey to root rot. The root system of a tree gradually extends through the soil as it becomes older, and when the roots have reached a point where they encounter unfavorable conditions, injury occurs and root rot can develop. In a number of cases groves have become 20 years old and then trees started to die out from root rot.

3. *Rootstock.*—Sour orange rootstock is more resistant to root rot than rough lemon, grapefruit, or sweet orange; it will, however, develop root rot under extremely adverse conditions.

4. *pH of Soil.*—Root rot is apt to be more important when the soil shows a pH of 7 or above. A good example of this is the so-called "road-side decline" where leaching from the crushed lime rock base of the highway has affected the soil in the row of trees adjacent to the road.

5. *Type of Soil.*—In general, root rot tends to be more of a problem on heavier soils. Also, in those soils where an impervious layer of rock, clay, or hard pan occurs within two or three feet of the surface, the incidence of root rot will be higher.

6. *Lightning Injury.*—In several instances trees that were known to have been slightly injured by lightning have developed root rot in subsequent years.

7. *Hurricane Damage.* — During severe windstorms the trees are severely shaken and twisted even though they are not blown over. This injures a portion of the roots in the soil and establishes conditions which are favorable for the occurrence of root rot.

Trees that become diseased with root rot do not usually recover and should be removed as soon as they are uneconomical. Treating the soil around root rot trees with 20 pounds of copper sulfate per tree or buck-horning the trees have not been beneficial. Young trees replanted in place of the diseased ones have always made excellent growth. In some cases replanting has been done immediately and in other instances a few months after removal of the old trees.

Spreading Decline

A discussion of the symptoms of spreading decline, its rate of spread, and varieties of citrus and rootstocks affected have previously been reported[2]. Since that report was presented, an additional 39 groves have been observed in which spreading decline occurs. Present distribution of the 93 affected groves in the various counties is as follows: Polk—66, Orange—8, Highlands—5, Manatee—5, Hillsborough—3, Pinellas—2, DeSoto—1, Pasco—1, Seminole—1, and Brevard—1.

The outstanding characteristic of this type of decline is the gradual spread of the disorder through the grove. There was a wide variation in the rate of spread observed in the groves for the 1948-49 season. A total of 56 groves were mapped and the rate of spread varied from 0.7 to 11.3 trees per tree on the margin of the declining area. This rate of spread was greater than has been found in previous years[2]. It has been suspected that the rate of spread might be accelerated by drought conditions. As shown in Table 2, there is an inverse correlation between the amount of rainfall occurring between October 1st and June 1st and the rate of spread, i. e., the less rainfall, the greater the rate of spread. To obtain these data 11 groves were mapped five times, 8 groves four times, and 7 groves three times at yearly intervals.

There are several possible causes that could induce spreading decline. Some of these are: a toxic organic material in the soil, a virus in the tree, fungus infection of the fibrous roots, the feeding of small insects on the roots, or nematodes infesting the fibrous roots. The senior author has reported[2] that preliminary investigations did not indicate the presence of a virus or a fungus disease. However, it was reported that the citrus nematode (*Tylenchulus semipenetrans Cobb*) was present in some groves and might be a causitive agent for this type of decline.

TABLE 2.
RELATION BETWEEN RAINFALL AND RATE OF SPREAD OF SPREADING DECLINE

	1945-46	1946-47	1947-48	1948-49
	Inches of Rainfall			
Oct. 1st to June 1st	24.22	24.59	27.01	13.83
	Average Rate of Spread			
11 groves	0.79*	1.2	1 02	2.21
19 groves	.....	1.26	1.03	2.82
26 groves	.....	.....	1.10	3.16

*Increase in number of diseased trees per tree on the margin of the declining area.

Assuming, as a working hypothesis, that the citrus nematode was the cause of spreading decline, a study of the nematode population in the various groves has been conducted during the past two years. High citrus nematode populations were found in 25 percent of the 93 spreading decline groves and in 6.5 percent of the 108 apparently healthy groves examined. The 23 groves in which the citrus nematode was definitely a problem showed a different type of decline when observed over a period of years than did those groves where this nematode was absent and which were typically spreading decline. Consequently, this would indicate that some of those groves which were previously classified as spreading

decline, are of a type not yet included in the decline survey and known in California as "slow decline." An area of decline induced by the citrus nematode may be confined to a portion of a grove or involve the whole grove. The distinguishing characteristic is the variation in the amount of decline shown by the individual trees in the general decline area in contrast to spreading decline where all the trees in the declining area show the same degree of decline. There is usually no sharp border between the slow decline area and the rest of the grove as is the case with spreading decline. Those healthy groves in which the citrus nematode was present may develop slow decline in years to come. In one Valencia block, slow decline showed up within three years after observations started. However, the length of time that the citrus nematode was present previous to the first observation of the grove is not known.

Since it appears that the citrus nematode is not a problem in the 70 groves which have typical spreading decline, it is possible that some other nematode might be causing the trouble. Counts of the total nematode population on the fibrous roots from 31 spreading decline groves and 29 healthy groves were made by the Baermann funnel technique. These counts showed such a similarity with respect to population and types that it is questionable whether another nematode is involved in spreading decline.

It is therefore imperative that some of the other possible causes of spreading decline be thoroughly investigated. Dr. I. W. Wander, Soil Chemist at the Citrus Experiment Station is conducting a series of experiments to determine whether some toxic material in the soil might be involved. In some instances very small insects have been found associated with fibrous roots of citrus trees. However, these have not been found consistently on roots from the various areas of spreading decline and it appears that they are not causing any serious damage.

There are several important virus diseases of citrus, some of which are tristeza, quick decline and psorosis. Although the preliminary experiments did not indicate the presence of a virus disease, a thorough investigation of this possible cause is in progress. A planting of various citrus seedlings and young budded trees has been established and tests are being conducted in this block, as well as the quarantine cage and the greenhouse to determine whether any virus disease is implicated.

Previously, it was found that a species of *Fussarium* could be consistently isolated from the roots of spreading decline trees. However, at that time, it was not possible to prove its pathogenicity. It still remains a possibility that spreading decline is the result of a fungus disease of the fibrous roots. A reinvestigation of the fungus angle is in progress. Large numbers of isolations are being made and inoculation experiments will be established covering a wide range of soil moisture and temperature conditions. Other factors that might influence root infection will also be studied.

Numerous experiments were conducted during the past five years in an attempt to control spreading decline. In the years 1945, 1946 and 1947 a total of 746 trees were treated by various methods. These were: trenching, chemotherapy, pruning or buck-horning and soil treatment with three kinds of mulches and 8 different chemicals at varying amounts. None of the treatments used during these three years has, to date, been successful or even given an indication that a partial control might be obtained. During 1948 and 1949 soil treatment with soil fumigants and organic insecticides were conducted. There were 452 trees around which the soil was treated with some of these materials. A total of 8 acres of grove was removed, the soil treated with D-D at 400 pounds per acre, and the areas replanted a month or more later. In another instance, at least 10 acres of grove were removed, the soil treated with benzene hexachloride (10 percent gamma isomer) at 100 pounds per acre, and then replanted. It is too soon to observe results where the replanting of an acreage was made after treatment. In the experiments involving 452 trees, none has shown satisfactory recovery of the trees or pre-

vented them from declining. In one instance, a soil treatment with a mixture of parathion and benzene hexachloride in water gave a significant reduction of 50 percent in the total nematode population of the roots. However, the trees have not yet shown any beneficial effect. In another case it appeared that trees treated with 5 or 3 pounds per tree of benzene hexachloride (6 percent gamma isomer) on the soil and disced in, did not show as much decline as adjacent non-treated trees. However, there has been no satisfactory recovery from any of the treatments to date.

Summary

A survey of 387 groves during the past five years showed that the four major causes of decline were spreading decline, root rot, foot rot and water damage and that these caused decline in 81 percent of the groves examined.

There are seven factors that influence the occurrence of root rot: water relations, age of tree, rootstock, pH of soil, type of soil, storm damage to roots, and lightning injury to roots.

A total of 93 groves have been observed in which spreading decline is present. The yearly rate of spread is accelerated by a reduction in rainfall between October 1st and June 1st. Among those groves previously classified as spreading decline, a total of 23 groves can now be classed as slow decline and are definitely associated with the citrus nematode *Tylenchulus semipenetrans* Cobb. The exact cause of the condition in typical spreading decline groves is not known.

Experiments on the control of spreading decline involving 1198 trees and an additional 18 acres of grove where the trees were removed have not shown any beneficial results to date. However, is some instances it is too early for a final answer.

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ARSENIC SPRAYS ON GRAPEFRUIT IN RELATION TO THE NEW CITRUS CODE

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The grapefruit maturity regulations which were in effect from 1939 through the 1948-49 season set certain minimum for soluble solids, ratio of soluble solids to titratable acid, and juice content. In actual practice it was found that the minimum soluble solids requirement was so low that nearly all grapefruit easily met this requirement, and juice content was a factor infrequently. In the majority of cases the ratio requirement determined the time of legal maturity of grapefruit.

Under this combination of legal restriction and fruit characteristics, the use of arsenic to produce early legal maturity of grapefruit was extensive. Since ratio was commonly limiting and since arsenic raises the ratio by decreasing the acidity of the juice, high concentrations of arsenic were used in order to obtain the legal minimum ratio by the time the minimum juice content was obtained.

The place which arsenic has held in the grapefruit production picture was thus created for it by the passage of grapefruit maturity laws in which low ratio commonly restricted shipments of fruit in the early part of the season. Whenever similar legislation exists, there will be a place in the production program for the use of arsenic to extend the early part of the grapefruit shipping season. When new maturity legislation is enacted, the regulations must be examined to determine how they modify arsenic use.

The Florida Legislature in 1949 combined all citrus legislation into one bill, and incorporated many changes into the maturity regulations. In relation to grapefruit there were two general features which deserve

Table 1.*

Time of Maturity and Quality of Grapefruit from Citrus Experiment Station, Block IX, Over A Seven Year Period.

Year	Last Sample Date	Variety	Data Last Analysis				Calculated Probable Passing Date
			% Soluble Solids	Ratio	Juice Content	Size	
1948-49		Duncan	Passed Nov. 16				
1947-48	Jan. 29	Duncan	9.10	6.59	259	64	March 15
1946-47		Duncan	Passed Nov. 16				
1945-46		Duncan	Passed Dec. 7				
1944-45	Oct. 27	Duncan	8.79	6.01	217	64	Feb. 15
1943-44	Jan. 18	Duncan	10.05	6.08	217	64	Feb. 23
1942-43		Duncan	Passed Dec. 1				
1948-49		Marsh	Passed Dec. 23				
1947-48	Jan. 29	Marsh	7.55	6.19	220	70	April 19
1946-47	Jan. 15	Marsh	8.80	6.54	210	70	Feb. 20
1945-46	Jan. 14	Marsh	8.75	6.47	278	64	May 20
1944-45	Oct. 27	Marsh	8.10	5.80	204	70	Feb. 17
1943-44	Jan. 18	Marsh	8.68	5.97	206	70	May 10
1942-43	Mar. 3	Marsh	9.18	6.79	216	64	March 25

* The author is indebted to J. W. Sites, Horticulturist, Citrus Experiment Station, for the use of the information contained in this table.

mention here. In the first place is the fact that the Florida Citrus Code of 1949 contains the old 1927 and 1929 Arsenic Spray Laws with the modification that the use of arsenic is not prohibited on grapefruit (1, Sec. 92-97). This removes the effect of the injunction of 1933 under which arsenic has been used on grapefruit for many years. In the second place are numerous changes in the maturity requirements. The revisions include the requirement of a color break and an increase in the soluble solids minimum requirements, but since color characteristics are not changed by application of arsenic and the soluble solids requirement is not so high as to restrict much grapefruit movement, they will not be of concern here. However, in other respects the 1949 Citrus Code contains maturity provisions which involve the use of arsenic. These are the continuous inspection of fruit throughout the year, and the changes in relative importance of juice content and ratio.

An entirely new feature of the 1949 Citrus Code is the provision for continuous inspection of grapefruit throughout the entire season. In the past, the inspection for maturity of

grapefruit was discontinued in December and from that time on grapefruit did not have to meet any maturity standards for any purpose. Now throughout the entire season all grapefruit must have a passing ratio before it can be shipped or used in processing.

There is not a great deal of information available on the composition of grapefruit in the extremely late part of the season, but there is ample information available to indicate that much grapefruit will fail to pass the ratio requirements in midseason, and some at least will fail in some years to meet the requirement until very late in the season. An example of this situation is afforded by the data in Table 1. These data are for a group of plots at the Citrus Experiment Station on which maturity records are available for several years. In most years the fruit was tested into late midseason, and in many cases the fruit failed to pass the ratio test as late as the sampling was continued. Low ratios were more common with Marsh than with Duncan grapefruit, although this is not known to be the general rule. Many similar examples from Station records could be cited in which fruit failed to pass the ratio test in midseason and the trend indicated that the ratio would continue to be low throughout the remainder of the season.

The survey of Harding and Fisher[2] also points out the seasonal nature of this situation. In the 1940-41 season, only half of the 16 groves in which they took samples had passing ratios in December, and only 75 percent had passing ratios in February according to the 1949 standards. One grove did not pass until May. In the 1941-42 season, however, all of the 20 groves tested passed the 1949 ratio test not later than the December sample. This season was in all probability similar to the 1948-49 season which was exceptionally early in maturity. However, in every year all of the groves sampled by Harding and Fisher did pass the 1949 minimum ratio test before their sampling season ended.

It is impossible to say whether the fruit from the grove at the Citrus Experiment Station used as an example (Table 1) would or would not have passed the ratio test if sampling had continued later into the season. The calculated probable passing date given in Table 1 are extrapolated values, but do indicate eventual passing of the ratio requirement. It may at least be concluded that in some years many crops will not pass the ratio test until very late in the season. This will restrict the time during which crops of fruit may be harvested, and may prove a handicap in marketing.

Production methods for ensuring passing ratios for grapefruit in midseason are thus desirable. The simplest and most readily available method for accomplishing this is the use of arsenic. Use of arsenic for this purpose is not to be confused with the use of arsenic to produce early fall maturity of fruit. To obtain early fall maturity it is necessary to use moderately high concentrations of lead arsenate in order to raise the ratio sufficiently in September or October to pass the test. For obtaining passing ratios in midseason it is not necessary to use high concentrations, for with the passage of time the effect of a given application of arsenic becomes greater. A low concentration will have as much effect on the ratio in February as a high concentration will have in September.

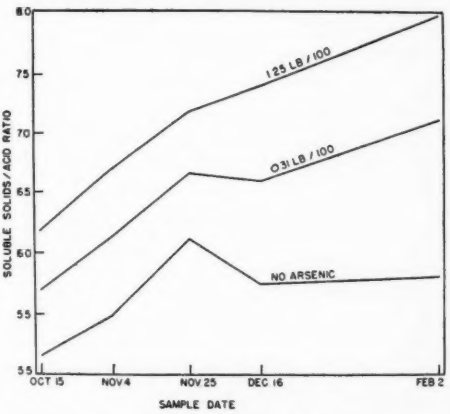

FIG. 1. Relative effectiveness of high and low concentrations of lead arsenate in raising the soluble solids/acid ratio of Marsh grapefruit during the 1947-48 season.

The data shown in Fig. 1 will make this clear. On October 15, 1947, fruit from a Marsh block at Lake Alfred showed a ratio of 5.14 where no arsenic had been used. Comparable plots sprayed with arsenic at 1.25 lb. per 100 gallons of spray mixture had a ratio of 6.18, or an increase of 1.04 ratio units. The increase produced by 0.31 lb. per 100 gallons was quite noticeable but smaller in extent. However, on February 2 the 0.31 lb. per 100 gallons rate had increased the ratio from 5.81 to 7.06, an increase of 1.25 ratio units. This is an example of the cumulative effects of an arsenical application, in which the margin between treated and untreated fruit increases as the season progresses.

Numerous other examples could be cited to show the relative effectiveness of small applications of arsenic in raising the ratio of soluble solids to acid during the middle part of the shipping season. In general, application of 0.3 lb. of lead arsenate per 100 gallons appears to be sufficiently high to ensure a passing ratio in nearly all groves by February. This application can be made at nearly any part of the growing season between bloom and the end of the oil spray season with satisfactory results.

The question may be raised as to why it would not be advisable to make a heavy application of arsenic to all groves in an attempt to get a part of the early market, and if this failed, still have ratios high enough to pass the test in midseason. There are several considerations which make this inadvisable. In the first place is the fact that two entirely different types of groves are involved. Groves which bloom early and for which the season is favorable may produce early fruit if given the high arsenic treatment, but even if not given the arsenic treatment, they still may pass the ratio test satisfactorily in midseason. If a grove blooms very late however, and is not favored by satisfactory growing conditions, no amount of arsenic will overcome this handicap and result in early maturity of the fruit. However, it is in this type of grove that the use of a small application of arsenic may be advisable to prevent undue delay in the passing of the ratio test for midseason fruit. In the second place, general heavy applications on all groves are unduly expensive, and may result in unnecessary toxicity to the trees. Furthermore, heavy applications lead to very high ratios in late season, and the fruit is thus made less acceptable for processing. In order to avoid these possible handicaps the grower should carefully consider the reason for the application of arsenic, and choose the rate which is suitable.

Quite aside from any legal maturity aspects, there is some basis for the belief that the use of arsenic on grapefruit is justified entirely by its effects upon the sweetness of the fruit. There is a growing opinion in the industry that the northern consumer would prefer to have a sweeter grapefruit than they now obtain from Florida, and that Florida grapefruit suffers to some extent in competition with Texas grapefruit because the Texas grapefruit is sweeter.

Specific data on consumer preferences is difficult to obtain, and consequently there is not much data available on the consumer preference for grapefruit ratios. Most of the evidence lies in the experience of the fresh fruit trade. Only the data of Harding and Fisher[2] are available to show the effect of arsenic on the palatability of grapefruit. Their work showed that the taste panel they used definitely preferred the fruit from the arsenic sprayed plots to the more acid fruit from the check plots.

If it is granted that the consumer would prefer to have a sweeter fruit, it is readily demonstrated that Texas produces a naturally sweeter fruit and hence must enjoy an advantage in selling. This position is based upon comparable analyses of Texas grapefruit and Florida grapefruit. The published analyses of Texas grapefruit by Traub, Fraps, and Friend[4], and Wood and Reed[5] show higher soluble solids and higher ratios for Texas fruit than are commonly found in Florida fruit. Lower ratios are quoted by Wood and Reed than by the former authors. In both these papers, with the exception of one plot near Mission where the bloom was exceptionally

late (5, Table 25), all ratio values quoted for the months of December and later are above 7.05 to 1 and generally are above 8 to 1 in January. This is in decided contrast to the information given in Table 1, and to that of Harding and Fisher[2], particularly for the season of 1940-41. The higher ratios obtained in Texas are obtained without the use of arsenic.

The difference in fruit quality is also reflected in the maturity laws of the two states (1, 3). In both cases, sliding scales of ratio values are used in which higher ratios are required for fruit with lower soluble solids levels. Texas grapefruit must have at least 9 percent soluble solids in contrast to a Florida minimum of 7.5 percent for seedless fruit and 8 percent for seedy grapefruit. The maximum ratio required in Texas is 7.2 to 1 while Florida requires a maximum of only 7.00 to 1. In addition, the Texas ratio scale slides to a minimum of 6.5 to 1 for fruit with 11.5 percent soluble solids, while in Florida it slides down to 6.00 to 1 for fruit with 12 percent soluble solids.

It is not to be assumed that Florida should adopt the equivalent of the Texas requirements. This would be completely impractical, since there are fundamental differences in rootstock, soil, and climate involved which make a 9 percent minimum soluble solids level for all Florida grapefruit a practical impossibility at the present time.

The thing that is indicated by these points is that the chief competitor of Florida is shipping a sweeter grapefruit than Florida does and apparently the consumers like that type of fruit very well. Wherever possible and practical then it would be advisable to compete on a stronger basis by shipping a sweeter fruit.

Continuous inspection tends to provide a sweeter fruit by eliminating the very low ratio fruit which formerly was shipped, but no doubt will lead to some difficulties with low ratio fruit as discussed above. A very effective aid to putting the sweetness of Florida grapefruit upon a competitive basis is through the simple and relatively inexpensive application of arsenic as outlined above. It is entirely possible that the application of arsenic for the purpose of sweetening the fruit and improving its palatability will become a standard practice among Florida growers.

The second aspect of arsenic use in Florida is concerned with the heavy application for the purpose of obtaining early maturity. Such applications have in the past been the sole use for arsenic, and as long as there is a high ratio requirement for grapefruit, there will probably continue to be a place in the production program for such use.

Too much reliance should not be placed upon the ability of an arsenic application alone to produce early maturity. There is substantial data available to show that the acidity and ratio of grapefruit juice are influenced markedly by some fertilizer elements, as well as by irrigation practices, time of bloom and general weather conditions during the year preceding the harvest. All of these factors are not understood but it is readily apparent that the use of arsenic will not overcome the disadvantage created by combinations of other factors such as lateness of bloom and unfavorable weather. Only where conditions are already favorable for the production of early fruit will the use of arsenic be advisable for early maturity purposes.

Such usage needs to be modified very little to fit the provisions of the 1949 Citrus Code. The general effect of the new law is to subordinate slightly the use of arsenic for early maturity rather than to emphasize it. This is the result of increasing the juice content requirement for grapefruit without a corresponding increase in ratio. Since the ratio is the factor acted upon by arsenic, and since the juice content is either not changed or slightly decreased by arsenic application, it follows that the use of arsenic for early maturity is slightly discouraged by the 1949 Citrus Code.

An example is given in Figure 2 in which the juice content and ratio requirements according to the old law were met on October 2. Since the soluble solids level was between 7.00 and 9.00 the ratio requirement remained the same under both the new and the old law.

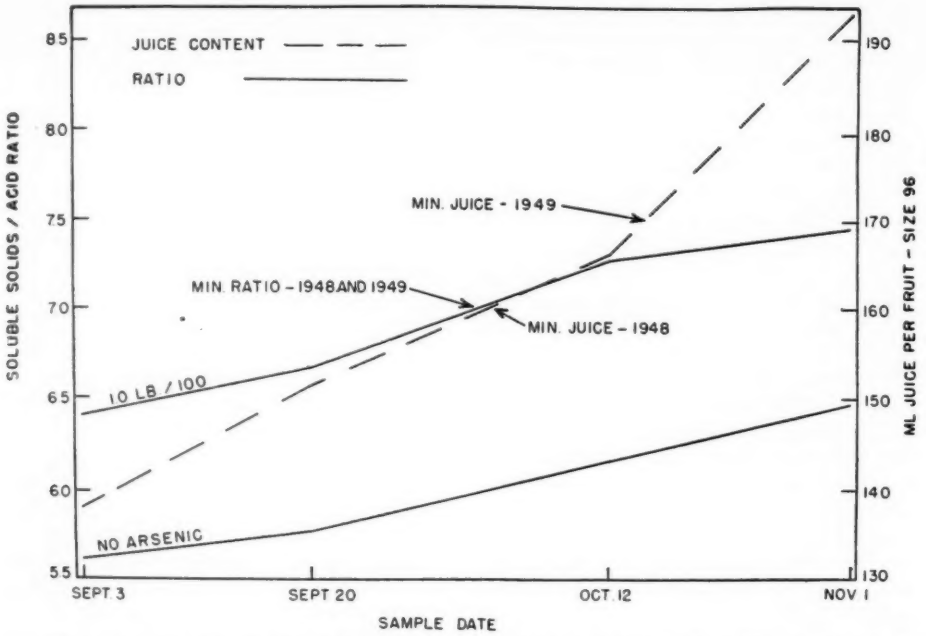

FIG. 2 Time of legal maturity of the 1948-49 crop of Marsh grapefruit in Block XI according to regulations in effect in 1948 and according to the 1949 Florida Citrus Code.

However, the new juice requirement of an additional 10 milliliters per fruit of size 96 delayed the attainment of legal maturity by 12 days. The point to note is that there would be no reason to have increased the rate of application of arsenic because of the 1949 law. Suppose in the example of Figure 2 that more arsenic than 1.25 lb. of lead arsenate per 100 gallons had been used. The ratio values would have been slightly higher than those shown for 1.25 lb. per 100. However, even by the 1948 standards this could not have resulted in earlier legal maturity for the treatment would not increase the juice content and this was limiting until October 2. Under the 1949 regulations the use of additional arsenic would have had the same result on ratio, but would have been less successful in advancing the date of legal maturity because of the increased juice content requirement which would delay legal maturity until October 14. Thus there is reason to decrease the rate of application of arsenic slightly, but for practical purposes the decrease indicated is so small that it is of very little importance.

Arsenic applications to grapefruit in light of the 1949 Citrus Code thus fall into two categories: those made for very early maturity and those made to sweeten the fruit and obtain passing ratios in midseason. For early fall maturity, applications of arsenic should be limited to groves which give promise of early maturity aside from arsenic application. In such groves arsenic sprays should be applied before the fruit exceeds an average diameter of 1.5 inches. A spray concentration of six pounds of lead arsenate per 500 gallon tank has usually given passing ratios by the time

passing juice content is obtained. For the purpose of obtaining passing ratios in midseason and general improvement of fresh fruit palatability, a rate of application of not more than 2 pounds of lead arsenate per 500 gallons is needed, and this amount may well be reduced as low as 1 pound per 500 gallons with adequate results. The spray may be applied any time from melanose time through the oil season. Excessive applications of arsenic are unnecessary, expensive, dangerous to the trees, and sometimes detrimental to fruit quality, and it is highly advisable to avoid such use.

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NUCELLAR SEEDLING STRAINS OF CITRUS

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You have asked us to prepare a paper for your program which will summarize our present thinking as to the value of nucellar seedling strains of citrus. The practical value of such strains as a means of rejuvenating some of the older varieties has been of especial interest to investigators and commercial fruit growers.

Perhaps we should first explain what nucellar seedlings are. In the reproduction of most *Citrus* species by seed, several seedlings may be produced from a single seed. One of these may be a gametic seedling produced by the ordinary sexual process. The others are produced from cells of the seed parent outside the actual egg cell. These cells make up the nucellus and seedlings arising from them are called "nucellar seedlings." These extra embryos which develop into nucellar seedlings are in some degree comparable to adventitious buds which push out from twigs and branches of trees.

In reviewing the possible practical value of nucellar strains of citrus we do not feel called upon to prove or disprove the theory that there is a general senescence of horticultural crops which are propagated by budding, grafting, and other comparable means. Many papers have been written on this subject, and possibly a part of the explanation for their not being in agreement, is their consideration of a wide variety of plant material grown under diverse conditions. Nucellar seedlings, however, have one outstanding characteristic which makes them of value as a means of rejuvenating citrus varieties.

So far as we know, all nucellar seedlings make an extremely vigorous and rapid growth. In any sort of a comparison one can make with budded progeny of a parent tree, seedlings or budded trees from the seedlings usually grow much faster than the parent stock. The nucellar strains, however, are much more thorny than the parent, produce flowers at least one or two years later, and generally come into full bearing very much slower. Some of these juvenile tree characteristics are commonly observed in citrus nurseries among seedlings grown for rootstocks. Such nursery trees are largely nucellar; that is why

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(1) Paper No. 628, University of California Citrus Experiment Station.

(2) Director, University of California Citrus Experiment Station.

(3) Assistant Geneticist, University of California Citrus Experiment Station.

(4) Frost, Howard B. 1938. Nucellar embryony and juvenile characters in clonal varieties of Citrus. Jour. Hered. 29:423-432. 3 figs.

they are so uniform and practically identical with the parent tree.

A careful study of nucellar strains was made by Dr. Howard B. Frost (1938)[4], who concluded that there is considerable evidence that the tendency to bloom and set fruit increases as the thorniness decreases. He was able to reduce thorniness greatly in the progeny trees by selecting budwood as free as practical from thorns. Fig. 1, taken from Frost, clearly demonstrates this, even though the buds were taken from a single unbranched water sprout about two yards long. Frost concluded: "The evidence here presented indicates that, in the propagation of promising new varieties, the reduction of thorniness can often be greatly promoted by selection of thornless budwood on trees which have grown about five to ten years in the orchard." The same investigator also concluded that seedling vigor is more persistent than seedling thorniness. This has an important bearing on the practical value of any nucellar strains.

The fruit characteristics of the nucellar strains, or as Frost called them, the "young clones" are equally important. In this regard Frost (1938) wrote as follows: "The fruits of young clones seem to have a fairly general tendency to greater elongation, greater firmness and ragginess of pulp, and earlier onset of over-ripeness changes, including core hollowness, rind puffing, and pulp granulation and drying." These unfavorable fruit characteristics should not be overlooked by anyone who is considering the planting of nucellar strains even as a limited experiment. Frost's observations have been confirmed by those made subsequently at Riverside. These unfavorable fruit characteristics, however, are much more evident with oranges and grapefruit than with lemons. Lemons are picked according to size, and in a rather immature state, and then cured. They thus escape some of the characteristics of aging to which oranges and grapefruit are subject.

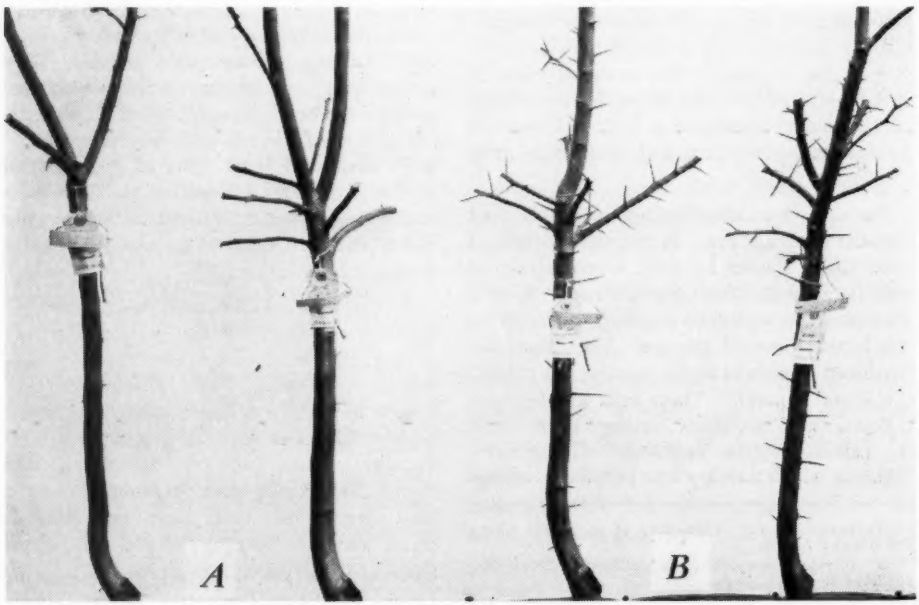

FIG. 1. Young trees, all budded from one unbranched, erect shoot. A—Two trees from budwood taken near middle of upper half of shoot, this half being almost completely thornless. B—Two trees from budwood taken near base of shoot and bearing thorns about 3 to 5 cm. long. (Photograph from Howard B. Frost, 1938.)

FIG. 2 Frost Eureka lemon tree, nucellar strain, sixteen years old. Compare this with the old clone tree in Fig. 3.

Several observers have noted that the fruit of young clones generally has fewer seeds in it than the old strains from which they have originated. This continues to be indicated in data obtained during the last two years even from our oldest nucellar strains.

The percentage of total solids in the fruit of nucellar strains of Valencia and Washington Navel oranges has been determined periodically during the past two years. In a dozen or more comparisons with the parent strains there has been no significant difference in the total solids. Comparable observations with Satsuma orange have consistently shown that the nucellar strains were higher than the parent strains in total solids. The percentages in 1948 and 1949 were approximately

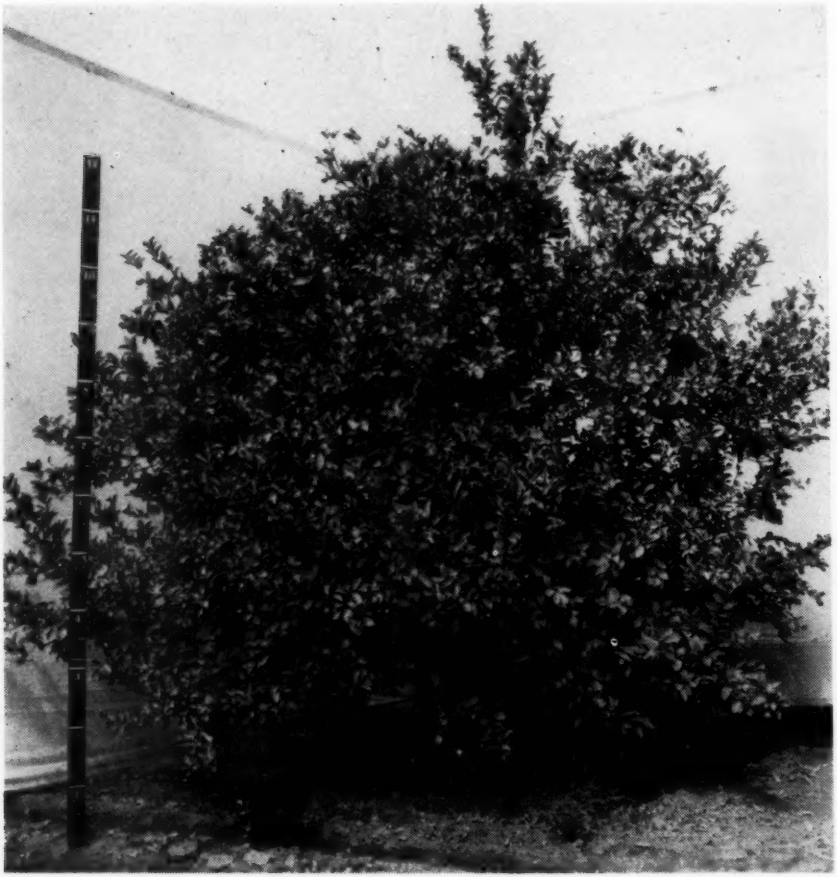

FIG. 3. Eureka lemon tree, sixteen years old; old clone strain budded from seed parent of tree in Fig. 2.

12.4:11.4 and 14.0:12.6, respectively, in such comparisons.

Perhaps we should explain now why we are interested in these nucellar citrus strains. There are several more or less distinct reasons, one or more of which are frequently applicable to individual cases. Of especial importance in California is the reinvigoration of the Eureka lemon variety by propagation from a nucellar seedling.

The Eureka is the most popular and produces the best quality fruit of all lemon varieties grown in the state. The tree characteristics are not so favorable. The trees have only moderate vigor, have a tendency to excessive bearing followed by outbreaks of "shell bark" and "dry bark" on the trunks, and often reach such a state of deterioration that a grove is unprofitable by the time the trees are fifteen years old. The nucellar strains seem to have enough added vigor to resist these diseases and are very promising at the present time. Fortunately this advantage is gained without sacrificing fruit quality or yield.

The contrast between the Frost Eureka, a nucellar strain, and the old parent strain of

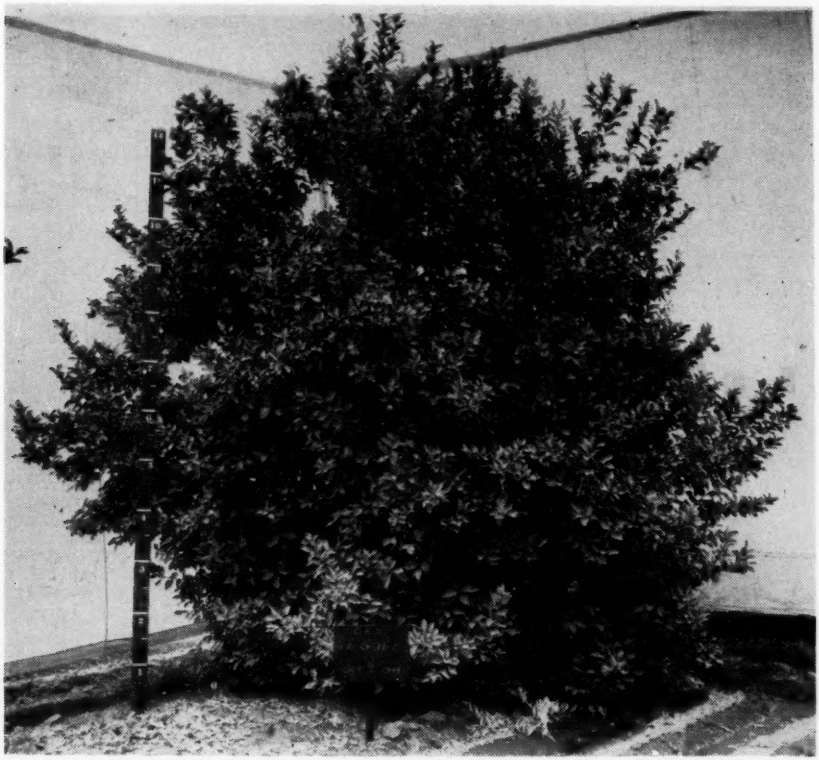

FIG. 4. Frost Eureka lemon tree, nucellar strain, eight years old; budded from tree shown in Fig. 2.

Eureka from which it is descended is shown in Figs. 2 and 3. Both trees are sweet orange rootstock and are sixteen years old. The Frost Eureka is the second budded generation from the original seedling which was produced in 1917. The Frost is entirely free from the physiological disease called shell bark in California, whereas the old clone tree is badly affected. There has been more contrast in the size of these trees during the past five years than there was formerly. We think this is due in some measure to inroads of shell bark on the old strain. The yields of these two trees have been in direct proportion to their size for approximately the past ten years.

A typical tree of the third budded generation of Frost Eureka is shown in Fig. 4 with the parent strain for comparison in Fig. 5. Ten trees of each sort on sour orange rootstock are growing in adjacent rows in our experimental plot. Shell bark symptoms have not appeared on any of the trees; nevertheless, the nucellar trees of this third budded generation are markedly larger than those of the parent strain. This added vigor of the nucellar strain of Eureka lemon has been of great interest to lemon producers in California and has justified their propagating more than one hundred thousand Frost Eureka trees during the past two years. These have been widely planted throughout the lemon-growing area of the State. Other selected strains of the original Eureka are being compared with the Frost Eureka.

Another example of conspicuous reinvigoration is the case of two nucellar strains of Owari satsuma produced by Dr. Howard B.

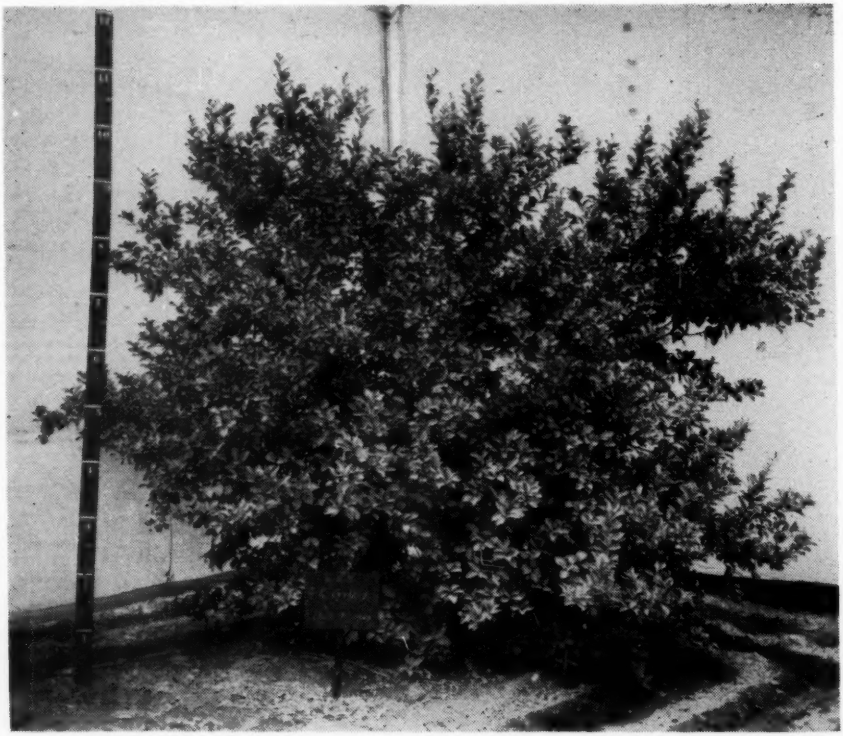

FIG. 5. Eureka lemon tree, old clone strain, eight years old; budded from tree shown in Fig. 3

Frost. Each shows much larger tree size than the parent strain of the same age. Over the last eight-year period the trees of the second budded generation of the nucellar Owari have yielded nearly twice as much fruit as the parent strain, and the fruit has colored earlier. The nucellar strain is now thirty-two years removed from the seedling parent.

Another reason for interest in more vigorous trees in general is our difficulty in California in making replants grow satsifactorily in old orchards. We used to think this was due primarily to competition with the old trees. We now are convinced that there are other factors operative in such cases. In any event, there have been so many practical failures in establishing replants that some orchardists are willing to accept all risk of undesirable characteristics of nucellar strains and to try them almost as a last resort.

In many instances in California, planting land to citrus a second time has proved a practical failure, even though the soil was well adapted to the original orchard. This applies to oranges as well as lemons. The trees of such second plantings have made a very poor growth. At a given age they have produced about half a crop compared with the original orchard at the same age. At present we are engaged in an extensive investigation to determine the causes of this trouble. The growing of other crops for four or more years followed by fumigation of the soil apparently does not entirely overcome the difficulty. Orchardists are therefore trying a few trees of these vigorous nucellar strains in the second

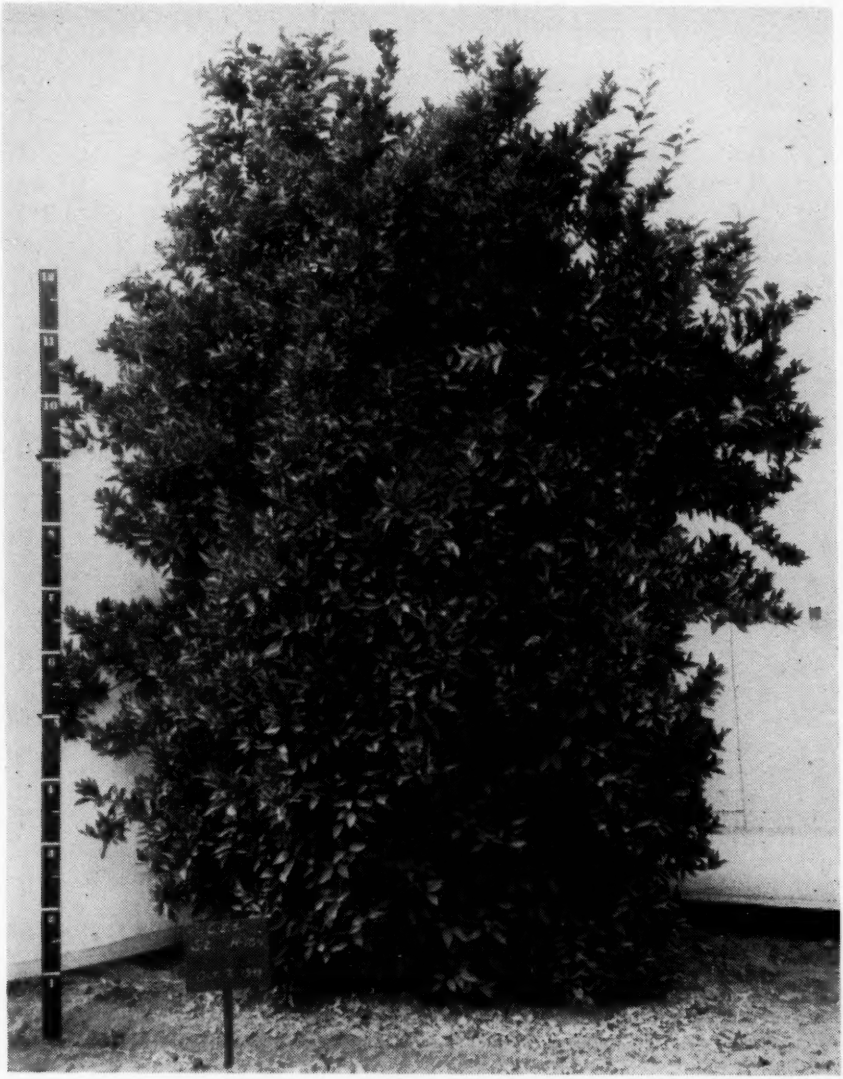

FIG. 6. Campbell Valencia orange tree, nucellar strain: first budded generation, seven years old. Compare with Fig. 7.

planting. The possible practical value of this procedure with oranges and grapefruit is still in doubt. With lemons, the results are very encouraging.

The typical contrast between a group of the first budded generation of nucellar Campbell Valencia trees and trees of the old original strain is illustrated in Figs. 6 and 7. So far as

FIG. 7. Campbell Valencia orange tree, old clone strain, seven years old. Compare with Fig. 6.

the late Dr. Howard S. Fawcett could determine, the original strain is free from any virus disease and is above average in size and vigor for the Valencia. Both the old and the new clone trees are budded on sweet orange rootstock and are now seven years old. The several nucellar strain trees have blossomed very little and have produced an exceedingly small amount of fruit, whereas the old clone has been normally productive. We have in the same orchard another nucellar strain of Valencia which is the third budded generation from the seedling tree and thirty-two years removed from its parent. In this case, however, the young clone is producing almost exactly the same amount of fruit as the old clone. The trees in the nucellar strain are more vigorous and produce somewhat larger fruit and are certainly more promising for an ultimately successful orchard. Several of these nucellar strains with such abnormal vigor are worth testing on old citrus land where ordinary strains have been a partial failure.

Another characteristic of the nucellar strains which we hope will be of value in California is that they often produce larger fruit than the old clones. The small fruit size in California, especially with Valencia oranges,

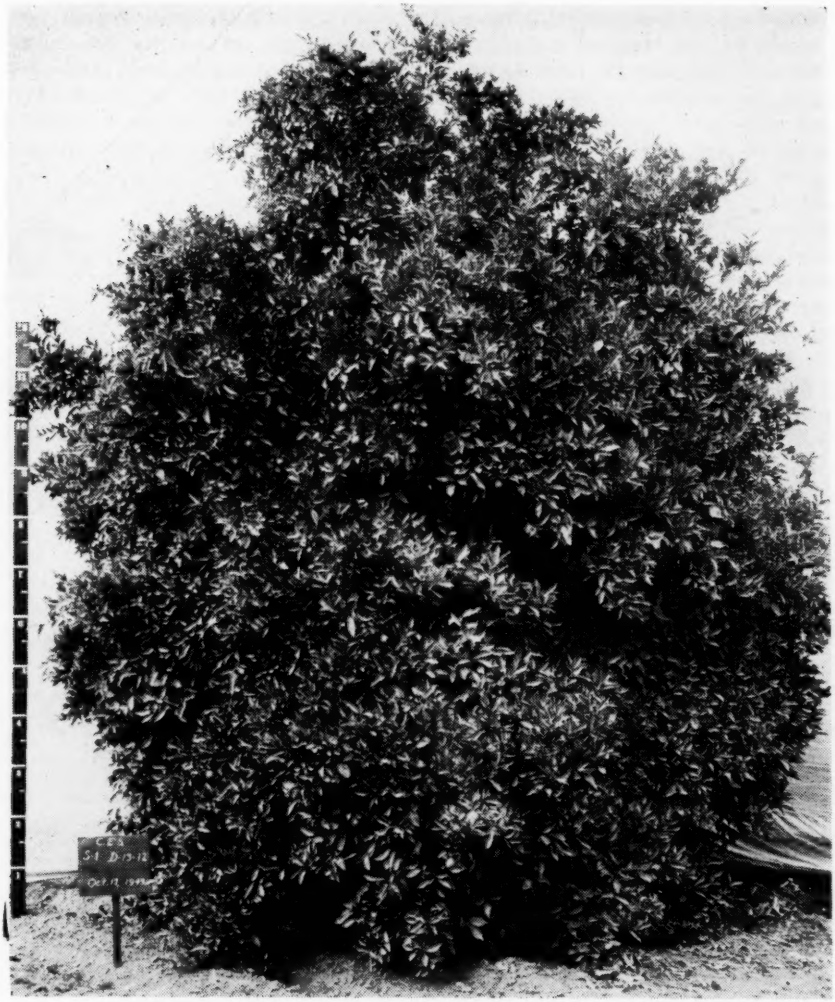

FIG. 8. Frost Valencia orange tree, nucellar strain, sixteen years old. Compare with Fig. 9

is an important problem. It is indeed a complex one with many factors in the equation. The vigorous nucellar strains are being tried in a limited commercial way as a partial remedy for this serious situation.

The fact that passing a variety through the nucellar seedling stage screens out virus diseases is perhaps the most important reason for our being interested in this procedure. Even though a virus disease such as psorosis has existed in the parent tree the seedlings are free from it. We are indebted to the late Dr. Howard S. Fawcett for many observations made on this point. His unpublished notes and a limited number of published articles show that a case of the transmission of the virus disease psorosis from the seed parent to the nucellar seedling is practically nonexistent. Some in-

vestigators have believed that possibly one of the reasons for the nucellar strains having so much more vigor than the parents was this factor of "screening out" such diseases as psorosis, and possibly other virus diseases which are not now detectable. Fig. 8 and 9 show trees from Frost's experiments which illustrate this very clearly. Fig. 8 shows a sixteen-year-old Frost nucellar Valencia tree free from psorosis. This is the second budded generation and is thirty-two years removed from the seedling tree. Fig. 9 is an old clone tree of the same age with psorosis symptoms in the foliage. These trees now yield in direct proportion to their size.

The importance of using nucellar seedlings in rejuvenating, in fact salvaging, some valuable variety of citrus which has been rather generally infected with psorosis or other virus diseases can hardly be overestimated. As an example, we are informed that the Ruby grapefruit has become very generally infected with psorosis. This could easily happen when old trees are topworked with a new variety and the new tops used as a source of budwood. A small percentage of old psorosis-affected trees would be enough to quite generally infect the next generation of trees. Passing the variety through the nucellar seedling stage to screen out the virus and then rebudding in a

FIG. 9. Valencia orange tree, old clone strain, sixteen years old; psorosis symptoms evident in the foliage. Compare with Fig. 8.

few years from as nearly thornless wood as possible becomes a practical and valuable procedure. Without this method of salvaging, such a variety might otherwise become relatively valueless.

In the case of the Eureka lemon we are not aware that any virus disease is involved. Yet the rejuvenated Frost Eureka, free from the physiological shell bark disease, is literally salvaging the Eureka variety.

The reinvigoration of the trees even in the absence of any virus indicates that the added vigor in nucellar strains is due in part to factors other than freedom from virus diseases. This is clearly shown also in the case of the Valencias illustrated in Figs. 6 and 7. Much research work has to be done to find out what these factors are. Probably there are several which contribute to these changes, and research work with viruses, hormones, and plant proteins will need to be carried out by chemists and plant physiologists before we fully understand this problem.

One more phase of the practical use of nucellar strains of citrus with which we are naturally concerned is the probable length of time that desirable characteristics such as vigor will persist within a single budded generation. Also, throughout how many budded generations should we expect them to persist? Our past experience has some bearing on the first question. Our oldest nucellar strains such as the Eureka lemon, are now thirty-two years of age and two budded generations removed from the original nucellar seedling. The great difference in vigor between the nucellar strain and the old parent strain has not decreased as time has gone on. It is clear, however, that our experiments are not old enough to really answer this question. The second part of the problem is also being investigated and we now have second, third, fourth, and fifth budded generations from the nucellar seedling growing in our orchards beside comparable budded generations coming down from the old Eureka strain. Even in this fifth generation we could see the difference in vigor in the nursery when the trees were one year old. We are now about to bud the sixth generation and plan to continue these studies several decades. At present, there is no clear-cut evidence of the old clone and new clone gradually approaching each other in vigor. Theoretically, we should expect them ultimately to do so.

In closing we might add that a general evaluation of nucellar strains of citrus varieties seems to us to be stimulating and valuable for the investigator and the practical orchardist alike. Both should try out, and closely observe nucellar strains in a constructive way, but make only limited use of them at present until more experience is gained.

The authors wish to express their appreciation to Dr. E. R. Parker, and Dr. W. P. Bitters for obtaining the illustrations of orchard trees for this paper.

PRESENT STATUS OF ORGANIC VERSUS INORGANIC NITROGEN AS RELATED TO YIELD AND FRUIT QUALITY

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The success of any fertilizer program is dependent upon the nutrient requirements of the crop, and upon the nature and characteristics of the soil on which it grows. If our citrus soils contained large reserves of the needed nutrient elements, citrus could be grown without the use of commercial fertilizer until the time when the supply of some particular element became exhausted in the soil and consequently became a limiting factor in the growth of the plants. Thus it is evident that the amounts and kinds of nutrients, and the form in which they are supplied by a fertilizer program are determined largely by the crop

response which results from their application.

In the early period of the development of the citrus industry in Florida the fertilizer program was not complicated by the need for supplying adequate amounts of magnesium, copper, zinc and manganese as it is today. Plantings at that time were limited largely to "hammock" soils, or to well drained heavier "flatwoods" soils which largely contained adequate supplies of the nutrients needed for the growth of citrus, and such fertilizers as were used were supplied as organics. These soils, although desirable from the standpoint of natural fertility, were usually so situated that groves suffered heavily from cold damage. As the industry developed and expanded, the increase in new plantings was extended to the light sandy soils in the State, which because of their better air drainage gave groves increased cold protection. This situation combined with the use of rough lemon root-stock which appeared to be so well adapted to these light sandy soils seemed to assure successful citrus production under these new conditions[1]. The series of events which followed, however, proved this to be an optimistic viewpoint, for although these soils were desirable in providing needed cold protection they were extremely low in natural fertility[2]. Approximately coincident with the time these new plantings were coming into production there developed a trend away from the organic fertilizers previously used in favor of less expensive inorganic fertilizer salts. These materials were relatively pure and contained little magnesium, copper, zinc or manganese all of which elements were present in the organics as sizable impurities. As a consequence of these changes there followed the gradual decrease in production and the general widespread occurrence of deficiencies of magnesium, copper, zinc and manganese which were so familiar to all those intimately engaged in growing citrus in Florida in the 1920's and 30's[1]. This rather brief historical outline is presented primarily to illustrate that it was not a question of whether nitrogen as such was supplied in an organic or an inorganic form which helped to precipitate the critical situation of the late 20's and early 30's. This condition was in reality, due to deficiencies of magnesium, copper, zinc and manganese which developed when these elements were no longer supplied as impurities in the fertilizers where inorganic sources of nitrogen and phosphoric acid were used. Inorganic nitrogen was relatively cheap, but its recommended use at that time was false economy and eventually cost the citrus growers of the State thousands of dollars. A fertilizer program that does not maintain production is poor economy even though it may be cheap in dollars. This paper may be considered a progress report on the present status of organic versus inorganic nitrogen sources. it cannot be considered final, but the results indicate definite trends.

Results

The results presented represent a portion of the data collected from Blocks IX and XI at the Citrus Experiment Station. The former is a fertilizer experiment involving Duncan and Marsh grapefruit varieties while the latter is a nitrogen source experiment conducted in a block of Hamlin oranges. The nutritional program followed in the grapefruit block is presented in Table 1 and that for the Hamlin orange block in Table 2. All other treatments of the plots being compared have been identical and in keeping with accepted grove management practices.

Internal Quality.—The internal quality, as characterized by the soluble solids, titratable acid and vitamin C content of the juice has been shown to be highly correlated with nutritional treatments for citrus. This relationship has been most pronounced between comparisons of deficiency conditions as contrasted to those where the deficient element has been supplied, but juice characteristics may also be considered a fairly reliable index of the efficiency of citrus nutrition where deficiencies are not involved.

The results of juice analyses of Duncan and Marsh grapefruit produced under 40 percent organic and inorganic nitrogen source fertilizer programs are shown in Tables 3 and 4. In order to conserve space only data for

TABLE 1.
NUTRITIONAL PROGRAM—BLOCK IX—MARSH AND DUNCAN GRAPEFRUIT*

Source of Nitrogen	Plot Nos.	Fertilizer Analysis Percentage N	P_2O_5	K_2O	MgO	MnO	CuO	Dormant Nutritional Spray Lbs./100 Gals. $ZnSO_4$	$MnSO_4$	$CuSO_4$
				1940-1943						
100% Inorganic	3 & 10	3	6	8	2	1	1	3	3	3
40% Organic	1 & 12	3	6	8	2	1	1	3	3	3
				1944-1948						
100% Inorganic	4 & 9	3	6	8	4	1	1	3	3	—
40% Organic	1 & 12	3	6	8	4	1	1	3	3	—

*Fertilizer applied Feb., June and Oct. at the rate of 15 lbs. per tree from 1940-45 and 20 lbs. per tree 1946-48. Lime is supplied so as to maintain an average soil pH of about 5.7. All plots received a neutral copper melanose spray.

the past four years are presented but these years cover a fairly wide range of weather conditions. All data presented represent seasonal average values for each of the years in question. These averages are based on the results of from 5 to 10 sampling dates during the period from September to February of each year so that the average values include samples taken both before and after the time that legal maturity was attained. These values have been found to be the best index of quality as single samples are more subject to reflect differences due to sampling errors. These values should not be associated with any specific date of sampling since they represent the average of all of the dates for any given year. The soluble solids content of the Duncan grapefruit juice was generally higher where a completely inorganic fertilizer program was followed, except for the 1948-49 season, when there was no appreciable difference. These differences were not large, the average difference amounting to only about 0.25 of one Brix unit over the four year period.

TABLE 2.
NUTRITIONAL PROGRAM—BLOCK XI—
HAMLIN ORANGES*(1)

Source of Nitrogen	Plot No.	Fertilizer Analysis—Percentage N	P_2O_5	K_2O	MgO	MNO	CuO
Ammonium sulfate	3 & 8	4	6	8	4	1	½
Sodium nitrate	2 & 7	4	6	8	4	1	½
Castor pomace	4 & 9	4	6	8	4	1	½
1/3 Ammonium sulfate 1/3 Sodium nitrate 1/3 Castor pomace	6	4	6	8	4	1	½

*All plots received 3 lbs./100 gals. Zns04, dormant spray and neutral copper melanose spray.

(1) Fertilizer applied Feb., June and Oct. at rates of 10 lbs. per tree 1944-45, 12 lbs. per tree 1946-47-48.

TABLE 3.
INTERNAL QUALITY OF DUNCAN GRAPEFRUIT AS AFFECTED BY 40 PERCENT ORGANIC AND INORGANIC FERTILIZER MIXTURES*

Source of Nitrogen	Fruit Size	Mls. Juice per Fruit	% Soluble Solids	% Titratable Acid	Ratio	Mgs. Vit. C/ 100 Mls. Juice
		1945-46				
40% Organic	70	251	9.11	1.47	6.22	44.0
100% Inorganic	70	250	9.41	1.49	6.31	45.2
		1946-47				
40% Organic	64	220	8.72	1.29	6.83	42.6
100% Inorganic	64	217	8.94	1.34	6.83	41.6
		1947-48				
40% Organic	64	223	8.36	1.28	6.66	38.7
100% Inorganic	64	217	8.75	1.31	6.74	39.9
		1948-49				
40% Organic	64	240	9.63	1.52	6.34	37.5
100% Inorganic	64	228	9.60	1.53	6.31	40.5

*Values included in above table represent the average of 5 to 10 samples taken each season from September to February, and include samples taken before and after fruit had reached legal maturity; they are not to be associated with any specific sampling date.

The citric acid content of the juice was also slightly higher on the average each year but this difference was not significant. No significant differences were found in the juice content, soluble solids, slash, titrable acid ratio, or vitamin C content.

Comparison and analysis of the Marsh grapefruit data showed that no consistent or

TABLE 4.
INTERNAL QUALITY OF MARSH GRAPEFRUIT AS AFFECTED BY 40 PERCENT ORGANIC AND INORGANIC FERTILIZER MIXTURES*

Source of Nitrogen	Fruit Size	Mls. Juice per Fruit	% Soluble Solids	% Titratable Acid	Ratio	Mgs. Vit. C/ 100 Mls. Juice
		1945-46				
40% Organic	70	227	8.60	1.39	6.14	41.4
100% Inorganic	70	231	8.48	1.38	6.15	40.8
		1946-47				
40% Organic	70	187	8.11	1.24	6.65	39.5
100% Inorganic	70	200	8.26	1.22	6.94	38.2
		1947-48				
40% Organic	70	186	7.60	1.26	6.10	33.6
100% Inorganic	70	185	7.78	1.27	6.23	34.3
		1948-49				
40% Organic	70	212	8.42	1.32	6.43	34.4
100% Inorganic	70	217	8.43	1.30	6.42	35.8

*Values included in above table represent the average of 5 to 10 samples taken each season from September to February, and include samples taken before and after fruit had reached legal maturity; they are not to be associated with any specific sampling date.

significant differences in composition of the juice were affected by these treatments.

Analyses of the juice data for Hamlin oranges are reported as seasonal averages for each treatment in Table 5. These average values include samples taken both before and after the period when fruit would pass the legal maturity standards, but the majority of the samples were taken before fruit was legally mature so that the time of passing the maturity standards each year for the block as a whole could be ascertained. These values should not be associated with any specific sampling date, they are used here since they reflect a truer indication of the effect of treatment and less difference due to sampling error than would be shown by samples collected on any single specific date. The highest soluble solids content was found in the juice of fruit from trees which received their nitrogen as ammonium sulfate. The lowest soluble solids content was found to be in the juice of fruit from trees which received all their nitrogen from the organic source, castor pomace. Dif-

TABLE 5.
INTERNAL QUALITY OF HAMLIN ORANGES AS AFFECTED BY THE SOURCE OF NITROGEN*

Source of Nitrogen	Size	Gals. Juice/Box	% Soluble Solids	% Titratable Acid	Ratio	Mgs. Vit. C/ 100 Mls. Juice
		1945-46				
Castor pomace	200	5.4	8.62	0.76	11.57	54.6
Ammonium sulfate	200	5.9	9.10	0.81	11.22	56.4
Sodium nitrate	200	5.8	8.75	0.80	10.87	57.5
1/3 each above sources	200	5.5	8.90	0.80	11.13	54.6
		1946-47				
Castor pomace	216	5.0	9.23	0.81	11.69	50.7
Ammonium sulfate	216	4.9	9.52	0.83	11.71	51.8
Sodium nitrate	216	4.9	9.48	0.80	12.06	54.0
1/3 each above sources	216	5.3	9.18	0.80	11.81	48.2
		1947-48				
Castor pomace	250	5.0	8.82	0.84	11.01	48.2
Ammonium sulfate	250	5.3	9.01	0.86	11.06	47.8
Sodium nitrate	250	5.1	8.79	0.86	10.83	43.1
1/3 each above sources	250	5.1	8.88	0.80	11.65	47.1
		1948-49				
Castor pomace	250	5.8	9.75	0.81	12.61	51.2
Ammonium sulfate	250	5.7	10.40	0.83	13.21	53.7
Sodium nitrate	250	5.6	10.25	0.81	13.47	54.6
1/3 each above sources	250	5.6	10.22	0.82	13.20	50.5

*Values included in the above table represent the average of 4 to 7 samples taken each season from September to February and include samples taken before and after fruit had reached legal maturity; they are not to be associated with any specific sampling date.

TABLE 6.
EXTERNAL QUALITY OF DUNCAN AND MARSH GRAPEFRUIT AS AFFECTED BY 40 PERCENT ORGANIC AND INORGANIC FERTILIZER TREATMENTS

Source of Nitrogen	Percentage of Fruit in U. S. Grades					
	Duncan			Marsh		
	U. S. No. 1	U. S. No. 2	U. S. No. 3	U.S. No. 1	U. S. No. 2	U. S. No. 3
			1945-46			
40% Organic	55.53	40.52	3.95	70.73	28.03	1.24
100% Inorganic	60.78	33.69	5.53	40.92	57.35	1.73
			1946-47			
40% Organic	42.61	48.03	9.36	43.95	45.00	11.05
100% Inorganic	60.78	33.69	5.53	38.86	49.72	11.42
			1947-48			
40% Organic	0.21	24.79	75.00	4.66	42.84	52.50
100% Inorganic	9.59	31.09	59.32	27.91	37.05	35.04
			1948-49			
40% Organic	76.72	16.92	6.36	46.96	47.17	5.87
100% Inorganic	66.99	27.01	6.00	47.85	44.62	7.53

ferences between these two treatments were highly significant. The soluble solids values for the other treatments were intermediate between these two and were not significantly different from them. There was no significant difference between any of the treatments in the other juice components studied.

In summarizing the effects of the treatments on internal quality its has been evident that there is a slight increase in quality in favor of the inorganic treatments with the exception of Marsh grapefruit. These differences are however not of sufficient magnitude to be of any practical commercial importance with the exception of the higher soluble solids content of the Hamlin juice from fruit taken from trees supplied with ammonium sulfate. Even in this instance the soluble solids were only significantly reduced where all of the nitrogen was derived from an organic source.

External Quality.—The effects of high organic and inorganic nitrogen fertilization on the percentages of fruit produced which would meet U. S. grade standards are shown in Tables 6 and 7. One of the points frequently cited in favor of high organic mixtures is the production of fruit of good texture, this is generally attributed to the slower and more uniform availability of nitrogen. Comparison of results from these plots failed to show any consistent advantage for either the inorganic or 40 percent organic treatments for Duncan or Marsh grapefruit, or for any of the sources of nitrogen which were supplied the Hamlin oranges in the production of fruit which would meet U. S. No. 1 standards, or in the size of the fruit produced.

Production.—The quality of fruit produced by trees under a fertilizer program determines to a considerable extent its usefulness for commercial operations. A fair indication of the possibilities of any fertilizer schedule can be ascertained only from a study of production over a fairly long period of time, and certainly cannot be judged by the performance during a one or two year period. The production data summarized and presented in Table 8 shows the average pounds of fruit per tree produced by both Duncan and Marsh grapefruit varieties during the period from 1940-41 through 1948-49. Production figures for the year 1944-45 are omitted since the October hurricane of that year removed almost all of the fruit and production records for that year were not taken. In comparing the 40 percent organic and inorganic treatments, Plots 3 and 10 (inorganic) are used for comparison with Plots 1 and 12 (40 percent organic) during the period from 1940 to 1943 since these plots were receiving only two units of magnesium in the fertilizer during that period. Beginning with the 1944 season, magnesium was supplied in amounts equivalent to four units of MgO to Plots 1 and 12 and for this period, comparison is made with inorganic Plots 4 and 9 which also receive this quantity of magnesium.

Comparison of these two varieties of grapefruit shows that the trees receiving the inor-

TABLE 7.
EXTERNAL QUALITY OF HAMLIN ORANGES AS AFFECTED BY SOURCE OF NITROGEN

Source of Nitrogen	Plot Nos.	Percentage of Fruit in U. S. Grades U. S. No. 1	U. S. No. 2	U. S. No. 3	Ave. Diameter (Inches)
	1947-48 Season				
Castor pomace	4 & 9	42.7	39.8	17.5	2.97
Ammonium sulfate	3 & 8	49.5	34.3	16.2	2.97
Nitrate of soda	2 & 7	38.3	40.0	21.7	3.00
1/3 Castor pomace 1/3 Ammonium sulfate 1/3 Nitrate of Soda	6	42.8	36.4	20.8	2.97
	1948-49 Season				
Castor pomace	4 & 9	62.5	35.6	1.9	2.89
Ammonium sulfate	3 & 8	60.2	36.9	2.9	2.81
Nitrate of soda	2 & 7	61.1	37.2	1.7	2.90
1/3 Castor pomace 1/3 Ammonium sulfate 1/3 Nitrate of Soda	6	68.1	28.1	3.8	2.88

ganic treatment have yielded larger crops than those on the 40 percent organic program. Comparing the 8 year average values for Duncan, the difference between the two programs shows an average increase in yield per tree of 145 pounds per year in favor of the inorganic treatment. Although this difference appears to be quite large, statistical analysis of the yield data shows it to be just short of significance. Failure to show significance was due to variation in yield between duplicate plots of the same treatment.

The yield of Marsh grapefruit produced under these programs shows the same trend as the Duncan, and is even more pronounced. The inorganic treatment yield was 207 pounds per tree per year higher over the eight year period than the organic treatment. Statistical analysis showed this difference to be highly significant.

Production data for Hamlin oranges as influenced by sources of nitrogen are presented in Table 9 for the five year period (1944 through 1948) in which the experiment has thus far been conducted. Trees receiving their nitrogen in the form of ammonium sulfate have to-date produced more fruit than has been produced by trees receiving any other single source of nitrogen in the experiment or from mixtures of the three sources. These trees over the five year period have averaged 570 pounds of fruit per tree per year as compared to 432 pounds of fruit for trees receiving all nitrogen from castor pomace. This difference of 138 pounds per tree per year is statistically significant. Differences in yield between trees receiving the castor pomace, sodium nitrate, and a mixture of the three sources were not significant. Further, there was no significant difference in yield between the ammonium sulfate treated trees and those which received nitrate of soda, or a mixture of the three sources, although only an additional five pounds per tree increase is required between the ammonium sulfate and the mixed source treatments to make it significant.

Considering all of the yield data it must be assumed that the trend at this time is

TABLE 8.
PRODUCTION OF DUNCAN AND MARSH GRAPEFRUIT AS AFFECTED BY SOURCE OF NITROGEN

Source of Nitrogen	Plot Nos.	Average Yearly Production (Pounds per Tree) 1940-41	41-42	42-43	43-44	45-46	46-47	47-48	48-49	Average Production Pounds per Tree 8 Year Period
		Duncan Grapefruit								
40% Organic	1 & 12	414	312	458	840	694	574	372	710	547
100% Inorganic	3 & 10* 4 & 9	788	190	927	762	933	786	452	703	692
		Marsh Grapefruit								
40% Organic	1 & 12	817	531	774	1015	1035	727	632	962	818
100% Inorganic	3 & 10* 4 & 9	948	862	1005	1199	1294	911	1240	698	1025

*Production for plots 3 & 10 from 1940-1943; plots 4-9 from 1944-1948.

TABLE 9.
PRODUCTION OF HAMLIN ORANGES AS AFFECTED BY SOURCE OF NITROGEN

Source of Nitrogen	Plot Nos.	Average Yearly Production (Pounds per Tree) 1944-45	45-46	46-47	47-48	48-49	Yearly Ave. Production per Tree for 5 Yr. Period
Castor pomace	4 & 9	120	492	460	620	468	432
Sodium nitrate	2 & 7	238	584	523	582	448	475
Ammonium sulfate	3 & 8	279	685	615	760	510	570
1/3 Sodium nitrate 1/3 Ammonium sulfate 1/3 Castor pomace	6	214	570	524	652	478	460

strongly in the direction of increased yields from the inorganic nitrogen source treatment as compared to 40 percent organic or 100 percent organic sources of nitrogen.

Discussion

The difficult problem in any research study is not to obtain the data itself, but to know how and where to make application of it so that the greatest good may be accomplished. It does not necessarily follow that a broad and general recommendation for the use of inorganic nitrogen based on the results of these plots is to be advocated at this time. It should be made very clear that the straight inorganic mixtures as reported here have given satisfactory results only because adequate amounts of magnesium, copper, zinc and manganese were supplied, and that where these nutrients were not supplied to other trees in the same experimental block, those trees have gone out of production due to deficiencies, suffer severely from cold damage, and produce poor quality fruit. It is recognized that there are growers in the State who do not supply supplemental elements in recommended amounts, or who apply them irregularly or only after deficiency symptoms are apparent to some extent. Under these conditions high organic mixtures should be recommended in preference to inorganic mixtures since the supplemental elements contained in the organics would tend to forestall the occurrence of grove decline due to deficiencies.

The use of high organic mixtures as insurance against the possible occurence of deficiencies not yet identified is another factor to be considered. There is less likelihood that a general, widespread, critical deficiency condition, such as occurred in the early 30's following adoption of inorganic programs will reoccur, since the plots at the Citrus Station which have been on inorganic programs for a number of years should show symptoms well in advance of commercial groves. With advance notice, such symptoms could be identified and corrective measures could be developed prior to its becoming a commercial problem.

All things are relative. While two decades ago it was wrong to use inorganic mixtures of nitrogen, phosphorus and potassium it does not necessarily follow that they may not be used to advantage today so long as they are supplemented with adequate amounts of the other required nutrients. It should be emphasized that such a program should be used only by growers who are willing to supply adequate amounts of magnesium, copper, zinc and manganese and who follow and observe carefully the performance of their grove. Only under these conditions, irrespective of the apparent advantages, does the use of a strictly inorganic nitrogen source fertilizer program appear to be tenable.

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STUDIES OF TRISTEZA DISEASE OF CITRUS IN BRAZIL

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III. *Further results on the behavior of citrus varieties as rootstocks, scions, and seedlings when inoculated with the tristeza virus*[1].

Investigations of the tristeza disease of citrus being carried on cooperatively by the Instituto Agronomico de Sao Paulo and the United States Department of Agriculture at Campinas, Brazil, have formed the basis for four previous publications [1 2 3 4]. The present paper reports further results obtained from the enlarged Rootstock Tests and Sour Tests previously described[3].

ROOTSTOCK TESTS

At the present time 6,850 plants representing 212 citrus varieties are being studied both as rootstock and as tops over sour orange. For purposes of analysis and discussion, the varieties have been separated into two main divisions: namely, Non-tolerant Rootstocks, and Tolerant Rootstocks. These terms are used because it is now known that the tristeza virus can enter and develop in the sweet orange tops. Thus the rootstocks, which have under the conditions of the tests shown tristeza symptoms on the sweet orange scions, are recognized as having tissues that do not tolerate the presence of the virus or its occompanying toxic products. These non-tolerant rootstocks may then be considered as unsatisfactory for commercial use in the presence of the tristeza virus. In contrast, the tolerant rootstocks are those which, under the conditions of the test, have developed to date apparently healthy growth even though subject to several inoculations and thus indicate that they have tolerant tissues and that they may have a potential value and use as rootstocks even in the presence of the tristeza virus.

Under the main division of Non-tolerant and Tolerant Rootstocks the varieties are organized by general botanical groups and listed alphabetically. The varieties shown in table 1 include the names of those previously reported[3] and the additional varieties that have shown reasonably definite responses to date. Fifty-eight varieties in the field tests have not yet developed sufficiently to warrant reporting at this time.

Of the 153 varieties shown in table 1, 84 are included in the list of non-tolerant or definitely unsatisfactory rootstocks for sweet orange in the presence of tristeza. These include 19 sour and bitter sweet oranges; 10 grapefruits; 10 tangelos; 19 pummelos, shaddocks, and hybrids; 18 lemons; 3 limes; a citremon; the Nippon kumquat; *Citrus macroptera;* and 2 forms of *Severinia.* In all cases the listed varieties when used as rootstocks for the Barao sweet orange have shown definite disease symptoms following inoculations with the tristeza virus. Valencia sweet orange also has been tested as a top over the majority of the listed varieties, and in all cases it has developed tristeza disease symptoms. It has not been possible to test all sweet orange varieties as tops over each rootstock, but we have been able to test seedling progeny of several sweet orange varieties over sour orange as a rootstock, and in all cases they have shown typical tristeza symptoms following inoculation. Some variations in time required and in degree of symptom expression have been observed on some of the non-tolerant stocks listed. Their reactions, however, are such that

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for the purpose of the practical citrus grower they should be considered as definitely unsatisfactory rootstocks for sweet oranges in areas where the tristeza disease occurs.

The classification of varieties as unsatisfactory is comparatively easy and can be relatively positive because of the definite disease symptoms that have been obtained in the tests. On the other hand, the listing of varieties in the tolerant rootstock group must necessarily imply that under the conditions of the relatively rigorous tests they have up to the present time remained apparently healthy in spite of the several inoculations made with viruliferous aphids.

The varieties that have up to the present time continued to grow in an apparently healthy condition are listed in table 1. It can be seen that there are 12 sweet oranges; 26 mandarins, tangerines, and hybrids; 16 tangelos; the trifoliate orange; 6 citranges; 6 citrumelos; and two sweet lemons. The value of the sweet oranges and mandarins as satisfactory rootstocks under tristeza disease conditions is considerably strengthened by the comparative consistency of the group reactions. It can be seen that among the non-tolerant stocks all of the sour oranges, grapefruits, shaddocks, and pummelos tested have been consistently unsatisfactory, whereas all of the sweet oranges and mandarins tested have so far proved to be tolerant. The validity of these group reactions is still further supported by the fact that hybrids between the non-tolerant grapefruits and the tolerant tangerines (tangelos) divide themselves into two distinct types of reaction, namely those that are non-tolerant and those that are tolerant.

TABLE 1.

LIST OF PLANT VARIETIES ACCORDING TO THEIR TOLERANCE OR NON-TOLERANCE AS ROOTSTOCKS FOR SWEET ORANGE, BASED ON TRISTEZA DISEASE NURSERY TESTS AT CAMPINAS, BRAZIL (a)

Non-Tolerant Stocks (Definitely Unsatisfactory)	Tolerant Stocks (Satisfactory as Tested)
Citrus aurantium L.	**Citrus sinensis (L.) Osbeck**
Sour and Bittersweet Oranges	Sweet Oranges
Algiers Seville	Chamoudi
Azeda sem espinhos (E.E.L.)	Enterprise
Bergamia	Florida Sweet Seedling
Bigaradier	Homosassa
Bittersweet (Stow Selection)	Jaffa
Dummitt Bittersweet	Lamb Summer
Dummitt Sour (x)	Lue Gim Gong
Egyptian Sour	Mediterranean Sweet
Florida Bittersweet	Pineapple
Lanceta Amarga (E.E.L.)	Ruby Blood
Limao Viradouro (E.E.L.)	Valencia
Myrtifolia	Washington Navel
Oklawaha	**Citrus reticulata Blanco**
Paraguay Sour (x)	Mandarins and Hybrids
Rehoboth Palestine	Chao Chou Tien Chieh
Sauvage PI 128348	Clementine
Sour U. S. D. A. No. 2 (x)	Cleopatra
Spain Sour	Dancy Tangerine
Tunis Sour	Kara
Citrus paradisi Macfad.	King (of Siam)
Grapefruits	Kinnow
Duncan (x)	Limao Periforme (var. Rangpur) (E.E.L.)
Foster (x)	Ling Ming
Leonardy (x) (*)	Mandarin (PI) 10630
Marsh	Mandarin (PI) 117477
Poorman Orange	Mandarin (PI) 114412
Red Blush (Webb) (x)	Murcott Honey Orange
Red Mexican (x) (*)	Nobilis (PI) 10642
Royal (x)	Oreco Tangerine
Ruby Red (Henninger Strain)	Ponkan (PI) 18027
Thompson (x)	Rangpur Lime
	Satsumelo C 10-V-3
	Suen Kat
	Sunki
	Swatow (PI) 10032
	Swatow (PI) 10031
	Swatow (PI) 14054
	Tangor C-653
	Temple

Non-Tolerant Stocks
(Definitely Unsatisfactory)

Citrus paradisi (x) C. reticulata

Tangelos (Non-tolerant)
Pina (x)
Tangelo (PI) 52018-W-2F
Tangelo 18-D-14 (x)
Tangelo 18-E-7
Tangelo 18-U-13
Tangelo 18-T-2 (x)
Tangelo 16-1-4
Thornton
Watt (x)
Wekiwa

Citrus grandis (L.) Osbeck

Pummelos, Shaddocks, and Hybrids
Asia Pummelo (C.E.S.) 2607
Cuban Shaddock
Flemmings Shaddock (C.E.S.) 578
Hawaiian Shaddock (C. E. S.) 454
India Red Pummelo (x)
Nakorn Pummelo (x)
Natsu Mikan (x)
Lemon Shaddock (C.E.S.) 579
Ogami Pummelo (x)
Pink Pummelo (C.E.S.) 2581
Pink Shaddock (C.E.S.) 577
Siam Pummelo (C.E.S.) 1220
Siamese Pummelo (x)
Tau Yau Pummelo (C.E.S.) 2583
Thong Dee Pummelo (x) (*)
Toranja Chineza (E.E.L.)
Toranja Kau Panne (E.E.L.)
Toranja Periforme (E.E.L.)
Zamboa (E.E.L.)

Citrus limon (L.) Burm. f.

Lemons (Non-tolerant)
Amber (E.E.L.)
Armstrong (E.E.L.)
Deodoro (E.E.L.)
Des 4 Saison (x)
Eureka (E.E.L.) (*)
Genoa (E.E.L.)
Harris
Lemon (PI) 10785 (*)
Lemon (PI) 126539
Lemon (PI) 136469
Lisbon (E.E.L.)
Lisbon (Tetraploide) (E.E.L.)
Meyer
Morocco
Selvagem (E.E.L.) (x)
Siciliano (E.E.L.)
Vicosa (E.E.L.)
Villafranca (E.E.L.)

Citrus aurantifolia (Christm.) Swing

Limes (Non-tolerant)
Beledy Lime (x)
Kadu Mul (Pink Lime) (x)
Kirk Lime (x)

Poscirus trifoliata (x) (C.) limon

Citremon (PI) 46216

Fortunella Hybrid

Nippon Kumquat

Miscellaneous

Citrus macroptera C.E.S. 432
Severinia buxifolia
Severinia sp.

Tolerant Stocks
(Satisfactory as Tested)

C. paradisi (x) C reticulata

Tangelos (Tolerant)
Minneola
Orlando
Sampson
San Jacinto
Seminole
Sunshine
Suwannee
Tangelo 18-H-6
Tangelo 18-I-13
Tangelo 16-A-1
Tangelo 18-I-8
Tangelo 16-N-7
Umatilla
Webber
Williams
Yalaha

Poncirus trifoliata (1.) Raf.

Trifoliate Orange (Large flowered)

Poncirus trifoliata (x) C. sinensis

Citranges
Cunningham
Morton
Rusk
Saunders
Savage
Troyer

Poncirus trifoliata (x) C. paradisi

Citrumelos
Citrumelo (PI) 4477
Citrumelo (PI) 4482
Citrumelo (PI) 4604
Citrumelo (PI) 4200
Citrumelo (PI) 4475
Winter Haven

Citrus limon (L.) Burm. f.

Lemons (Tolerant)
Columbia Sweet Lemon
Sweet Lemon (PI) 1158

Footnotes:

(a) Methods of inoculating and testing stock-scion combinations have been previously reported (3).
(x) Varieties that have shown tristeza disease symptoms on inoculated, unbudded seedlings in field tests.
(†) Tristeza disease symptoms obtained on very young potted seedlings under controlled screenhouse conditions.

(PI) USDA Plant Introduction number.
(C) USDA Crop Physiology and Breeding number.
(C.E.S.) California Citrus Exp. Sta. Number.
(E.E.L.) Citrus Exp. Sta., Limeira, State of Sao Paulo, Brazil.

The apparently individualistic responses of the trifoliate oranges have previously been discussed [3,4]. It is tolerant as a rootstock for sweet orange, and even when inoculated over sour orange rootstock has shown no disease symptoms.

The hybrids of trifoliate orange that have been tested in Campinas are shown in table 1. The six citranges and the six citrumelos have so far proved to be tolerant as rootstocks for sweet orange. In contrast, however, a citremon has been found to be non-tolerant.

As previously reported[3], of the four lemons that had been tested two were found to be non-tolerant and two were tolerant as rootstocks. During the past year numerous lemons were tested and as shown in table 1, there are 18 that have proved to be non-tolerant as rootstocks and only the two sweet lemons remain as tolerant rootstocks. It seems possible that these two lemons may eventually prove to be hybrids or bud mutations. The rough lemon, although tending to be tolerant as a rottstock, has been somewhat variable. Thus it was not included in table 1 but its reactions are mentioned in the discussion later in this paper.

The three lime varieties tested in the past year have been found to be non-tolerant as rootstocks for sweet orange. It should be pointed out that the so-called Rangpur lime is really not a lime but is considered to be either a lime-manderin hybrid or a sour mandarin type, and it is tolerant as a rootstock.

As shown in table 1, the Nippon kumquat, *Citrus macroptera,* and two *Severinias* are non-tolerant as rootstocks. At the moment the knowledge that Severinia is a non-tolerant stock is of interest but its significance is not yet apparent, although in the future it might possibly have some value as a test plant.

Citrus Seedlings and Tristeza Disease

Although the possibility of finding citrus varieties that would show tristeza disease symptoms on their own roots was recognized earlier [2,3], the proof that this occurs on a relatively wide range of citrus seedling material has been the result of the extensive tests carried out at Campinas, Brazil. In a previous publication there was presented[4] a list of 45 citrus seedling varieties of the following groups: 9 sour oranges, 8 pummelos and shaddocks; 6 lemons; 11 grapefruits; 6 tangelos; and 5 limes. It did not seem necessary to repeat the entire list; but for the convenience of the reader the majority of the names of the varieties can be found in table 1, where the varieties included in the previous list as showing symptoms on unbudded seedlings, are here marked with an (X) for those tested under field conditions and with an (•) for those tested under controlled screenhouse conditions.

These findings have an extremely important bearing on our knowledge of the disease. Emphasis in the past has been centered mainly around various stock and scion combinations in relation to the disease. The recognition that unbudded seedlings show symptoms following inoculation allows a greater opportunity to study symptoms and virus reactions on individual varieties and at early stages of growth. It also increases the possible chance of finding a test plant that can serve as a means of detecting virus presence. Such a test plant on its own roots would greatly reduce the labor, expense, and time involved as compared with the currently used test plants where it is necessary to have sweet orange tops on sour orange rootstocks.

Sources of Budwood

In a previous report[4] results from field tests were presented showing that the reaction of buds from infected trees on different rootstocks varies not only according to the tolerance or non-tolerance of the rootstock tissues, but also according to whether the buds themselves belong to the types that possess non-tolerant or tolerant tissues. Again it was noted that buds from infected trees of a tolerant type, such as sweet orange, when budded on a non-tolerant stock, such as sour orange, produced a first flush of growth that was apparently healthy, but which later showed disease symptoms. For a period of about two months from date of budding there was little or no difference between sprouts from healthy or infected buds from tolerant types. In contrast, when infected

buds of non-tolerant types (such as those marked with an (X) in table 1) are budded on non-tolerant stocks, disease symptoms appear practically as soon as the bud starts. Observations indicate that buds from infected trees of tolerant citrus types when budded on tolerant stocks usually do not develop symptoms even though the plant is a carrier of the virus. On the other hand, observations indicate that buds from infected trees on non-tolerant citrus types when budded on tolerant stocks may at times produce some symptoms. In the previous publication[4] a possible explanation for the above-mentioned reaction was presented, based on the relation between virus movement and food translocation in the plant.

On the basis of present knowledge, then, it appears very desirable in the case of the non-tolerant varieties, such as grapefruit, to be relatively sure that the source of budwood is free from the tristeza virus. In the case of tolerant varieties, such as sweet orange, it would seem desirable to have a virus-free source of budwood; but on the basis of experience in Brazil, tristeza-virus-infected buds of sweet orange can be employed in successful propogation of sweet orange on tolerant rootstocks.

Sour Test

In the Sour Test, as previously described[3], all of the varieties that have been employed in the Rootstock Test as rootstocks are budded as tops on sour orange rootstocks. In a previous report[3] it was noted that the sour orange over sour orange rootstocks did not show tristeza symptoms. During the past year, however, with repeated inoculations a few individual plants of such combinations have been observed to show disease symptoms. This change and other general aspects of the results from the Sour Ttest are herewith briefly discussed.

In field tests where plants growing over sour orange rootstocks were inoculated three times with viruliferous aphids, 100 percent of the sweet orange plants representing 5 varieties have showed disease symptoms, 14 varieties of mandarins gave 90 percent diseased plants, 13 varieties of tangelos showed 94 percent diseased plants, and 10 varieties of grapefruits resulted in 90 percent of the plants with disease symptoms. In the case of the ten varieties of pummelos and shaddocks tested, only 37 percent of the plants showed symptoms and three varieties namely Ogami and Siam pummelo and Pink Shaddock C. E. S. 577 showed no disease symptoms on the five plants of each that were tested. Among the 15 varieties of sour orange tested as tops over sour orange rootstocks only 15 percent of the plants representing only 8 of the varieties showed definite disease symptoms. The true trifoliate orange tested as a top over sour orange has not yet shown any recognized disease symptoms. Similarly none of the 8 varieties of citrumelos tested have developed any positive disease symptoms. In contrast, however, 3 of 6 varieties of citranges when grown over sour orange rootstocks and inoculated, have shown definite disease symptoms. The three varieties showing symptoms were the Savage, Rusk, and Saunders citranges, and 93 percent of the inoculated plants of these varieties gave positive symptoms.

When one combines the results listed above with the percentage of plants showing symptoms following each of the inoculations and when one compares the degree of symptom expression[4] then a rough estimate of host-virus relations may be obtained. In general the sweet oranges and the tangelos appear to be particularly favorable hosts for the virus and are readily infected by the viruliferous aphids. The mandarins also seem to be favorable hosts for the virus but in some instances they do not appear to be as easily infected. In distinct contrast the trifoliate orange and some of the citrumelos and some citranges appear to be unfavorable hosts for the virus. At the same time, some of the citranges seem to be as favorable hosts for the virus as are the sweet oranges. The grapefruits, shaddocks, and pummelos, and the sour oranges would appear to represent intermediate types of host-virus responses, and it seems likely that some variations may be expected in relation to reactions of specific varieties in these groups.

Obviously the above discussion represents only a general concept and needs confirmation from many angles. Nevertheless, it forms a basis for estimating plant responses and for noting possible variations. For instance, some of the lemon varieties now under test are showing definite tristeza disease symptoms when budded over sour orange rootstocks and inoculated. There are ,however, some lemon varieties that have shown only questionable or mild symptoms and exhibit a tendency to recover from symptom expression. There are initial observations and the continued behavior of the lemons will be followed with interest.

In general the kumquats tested appear to be less favorable hosts to the virus than even the sour orange. In the case of the Nippon kumquat we have repeatedly inoculated without success. To date the Nagami kumquat has been something of an exception in that in one test series it gave symptoms on three of the five plants inoculated. *Severinia buxifolia,* as tested to date as a top over sour orange rootstock, has remained apparently healthy and would seem to be an unfavorable host for the virus. When used as rootstocks, however, both Severinia and the Nippon kumquat are non-tolerant, as already noted.

The above concepts must of course be tentative, since much of the information is based on the results of inoculations using viruliferous aphids. More recently it has been found that buds from infected trees are more effective than aphids in producing disease symptoms on sour orange. It may also be pertinent that buds from infected sour orange can be used to transmit the disease but as yet we have not been able to get transmission using aphids fed on diseased sour orange and then transferred to test plats.

The Sour Test continues to provide a means of estimating host-virus reactions and is of special value from the scientific standpoint. The results of these tests also effectively demonstrate that the fruit grower cannot safely use, under tristeza disease conditions, the sour orange as a rootstock for sweet oranges, mandarins, grapefruits, or tangelos. The Sour Test provides one means of detecting presence of the tristeza virus in areas not previously infested, and it provides information on host-virus responses that are of value to those who are concerned with the formulation of protective quarantine measures.

Discussion

In areas where the tristeza virus occurs or where it is likely to occur, the practical citrus grower must make decisions as to what he is going to do. The cooperative investigations of the Instituto Agronomico and the United States Department of Agriculture at Campinas, Brazil, have produced results that can be of service in helping him to make at least a portion of the decisions. From the data presented in table 1, it becomes increasingly obvious that in any new plantings made, the grower should not at the present time employ as rootstocks any sour oranges, grapefruits, pummelos, shaddocks, or other varieties tested and found to be non-tolerant to tristeza.

Among the tolerant rootstocks listed the grower may wish to select an individual variety because of previous experience and a knowledge that it is suited to the soil and local environmental conditions under which he is operating. From the standpoint of tristeza the sweet orange would appear to be a safe and satisfactory roostock for sweet orange. The Caipira sweet orange in the Limeira Citrus Experiment Station's rootstock tests established prior to the occurrence of tristeza in that area, has proved to be a very satisfactory stock both for sweet orange and for Marsh grapefruit. The Rangpur lime, a hybrid or sour mandarin type, has also proved to be a good rootstock for sweet orange; but as a rootstock for grapefruit it appears to be somewhat susceptible to gummosis or foot rot under the conditions of the test. The Cleopatra mandarin, as tested at Campinas and in nursery and young field plantings at Limerai, has so far appeared to be a satisfactory rootstock. It seems likely that some of the other mandarins and mandarin hybrids listed will be found to be satisfactory.

The trifoliate orange is exceptional for, as tested to date, it has been found to be tolerant as a rootstock for sweet orange and as a top

over sour orange it does not show symptoms. As observed by one of the authors on a recent field trip, it is being used extensively in tristeza-infested areas in Uruguay and in parts of Argentina as a satisfactory roostock. Its use in Uruguay has been particularly recommended (a) not only because of the tristeza problem but also because of its adaptability to local soil conditions and apparent resistance to foot rot. The trifoliate orange has some well known climatic and congeniality limitations but with careful selection and handling in the nursery, it is proving to be a satisfactory stock in some areas.

Of the 13 trifoliate orange hybrids tested at Campinas, 12 are listed as tolerant and 1 as non-tolerant. The hybrids would appear to offer some advantage in that certain ones are relatively more vigorous in growth habits. However, the fact that one was found to be non-tolerant indicates the need to have the particular trifoliate hybrid tested before any large-scale use of it as rootstock could be recommended.

For the citrus growers interested in producing grapefruit the recommendation that none of the non-tolerant stocks should be employed is the same as in the case of the sweet oranges. However, the specific mention of desirable tolerant stocks cannot be made other than to say that the listed tolerant stocks for sweet orange form the safest basis for choice under the present limitations of our knowledge. Tests of some of these with grapefruit tops are under way.

Thus far the tests in Campinas show that the reactions of the mandarins and the tangerines as tops over various rootstocks are similar to the sweet oranges so that the growers of these types of fruits might be guided by the same information presented for the sweet oranges.

The results presented in table 1 show that 3 limes and 18 lemons tested were found to be non-tolerant as rootstock for sweet oranges. Some of these limes and lemons have also shown symptoms when inoculated as seedlings. The following is a discussion of some of the reactions observed both in the current tests and under field conditions in Brazil.

In the case of the limes tested in the nursery plantings over sour orange rootstocks definite tristeza symptoms have developed following inoculation. The three limes listed in table 1 have also shown symptoms on unbudded seedlings and in addition the Key lime showed symptoms following heavy aphid inoculation of very young seedlings in the screenhouse. The Kirk lime, which appears to be particularly susceptible to tristeza, has also shown definite mild disease symptoms and stunting even when budded and inoculated over tolerant rootstocks in the screenhouse. In contrast, the Kalpi lime, although showing disease symptoms over sour rootstock, has, as a stock for sweet orange, produced only questionable and not positive tristeza disease symptoms on the sweet orange tops.

It is of interest that in one instance under field nursery conditions, the Kadu Mul pink lime has showed a remarkable tendency to produce continuing growth even from buds from infected trees budded over sour orange rootstock. This growth was not half as good as that from the healthy control buds, but it was far more than that obtained from comparable buddings of other citrus varieties in the test that had virus-infected non-tolerant tissues. Why there was a partial degree of recovery is not well understood, and these variations in reaction illustrate the need for continued study of the limes.

The situation with respect to the behavior of the lemons as seedlings and as tops over various rootstocks is also not yet clear. A decline of lemons was present in Brazil even prior to the advent of tristeza but, as was noted in a previous report, the Eureka lemon has been observed in orchards in Brazil to develop well over sour orange rootstocks even in areas where tristeza disease is prevalent. Under screenhouse conditions, however, we were able to infect some Eureka lemon seedlings and produce symptoms. Similar results were also obtained in the field nursery plantings of Eureka lemon seedlings; and when buds were taken from the diseased and healthy seedlings and budded over sour orange

(a) Recommendations by Pathologist Lucia Koch de Brotos of the Uruguayan Department of Agriculture.

rootstocks the growth from infected buds was characteristic of the effects produced with buds from infected trees of other non-tolerant varieties, i. e., stunting and yellowing. The average growth from the healthy buds was 59 centimeters at the end of five months as compared with an average of only 14 cm. for the diseased buds.

It can also be noted in table 1 that three other lemons have been inoculated as seedlings and have subsequently developed tristeza disease symptoms. It is indeed fortunate that we already have under field tests the Eureka lemon budded and inoculated over approximately 80 different rootstocks. It is hoped that their reactions will throw more light on this problem.

At the present time there is conflicting evidence with respect to the use of Rough lemon as a rootstock in tristeza-infested areas, and it has not been listed in table 1. At Campinas the seedlings so far tested have in general exhibited tolerance to the tristeza virus. At Limeira the Brazilian type of Rough lemon proved to be a better stock than the Florida type of Rough lemon. At Piracicaba the reverse was true. No one can be sure of the part that tristeza played in bringing about these differences. Recently, however, at Limeira considerable yellowing and mottling and stunting appeared on sweet orange tops budded on Brazilian Rough Lemon plants in the nursery. Whether this was related to a virus infected source of budwood or not, has not yet been determined but tests are being undertaken to find out. In Argentina it was observed (b) that the so-called Rough lemon imported about 1929 from Australia was apparently tolerant to tristeza. It was, however, noted that there were appreciable differences in top growth size and form in trees over the Rough lemon stock, indicating that the rootstock employed was not necessarily uniform.

The results from the testing of lemons at Campinas (table 1) show that the large majority of true lemons are non-tolerant as rootstocks for sweet orange. The two sweet lemons that have shown tolerance may possibly be bud mutations or hybrids. On the basis of our present knowledge of the behavior of such hybrids as the tangelos and the trifoliate hybrids, it seems entirely possible that some Rough lemon types may be found that will be tolerant and that others may show degrees of non-tolerance. In order to safeguard the grower who wishes to use Rough lemon as a rootstock, it may be desirable to establish individual seed sources and test these as to their tolerance or non-tolerance to the tristeza virus.

(b) Observations made in company with E. P. DuCharme and J. R. King.

Summary

The behavior of citrus varieties as rootstocks, scions, and seedlings, when inoculated with the tristeza virus is discussed. A list is given showing 84 varieties tested and found to be non-tolerant and therefore unsatisfactory as rootstocks for sweet oranges under exposure to tristeza virus infection. Also a list of 69 varieties is given of those that have satisfactorily survived the rigorous tests and are thus rated as tolerant rootstocks.

The discovery is mentioned that unbudded citrus seedlings of numerous varieties can show tristeza disease symptoms following inoculation.

The importance of sources of budwood is discussed with respect to the presence of tolerant and non-tolerant tissues in the sweet orange and the grapefruit; and the desirability of having virus-free sources of budwood, especially in the case of the grapefruits, is noted.

The general discussion attempts to interpret the results of the tests with respect to the problems facing the citrus growers in areas where the tristeza virus may become an important problem.

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CITRUS CULTURE IN SOUTH AFRICA

T. Ralph Robinson

Terra Ceia

In discussing this topic with Florida citrus growers the first consideration is the water shortage common to the South African areas where citrus is grown. This means that their methods of culture more closely resemble those used in California than in Florida. Wherever possible dams are built to save all the water possible, water rights are parceled out to the growers, often not enough. So the growers put down "boreholes" or wells, to supplement their supply. On the higher portions of the grove property reservoirs are built to serve in irrigating by gravity. Usually one of these reservoirs serves as a swimming pool. In some places these pools cannot be used safely without treating the water with copper sulphate. A disease called Bilharzia carried by snails along the ditch banks acts much like hookworm, only worse. Africa has its insect problems, some of them as the tsetse fly, very terrible.

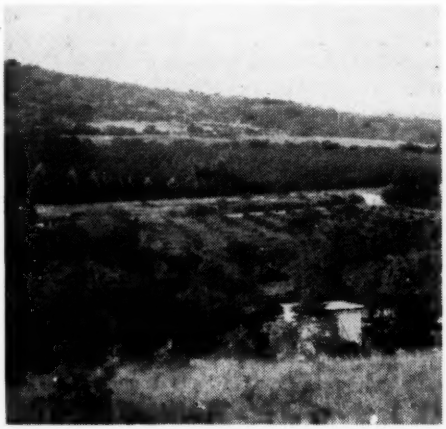
Perhaps the obscure aphids or similar tiny insects that carry virus diseases from plant to plant may in time prove as dangerous to the economy of the country as others long recognized and being fought with all the tools of science. Dr. Von der Planck, at the meeting of the South African Association for the Advancement of Science held at Kimberly in July, emphasized this point, pointing out the grave menace to orchard crops from insidious virus diseases in South Africa, but without going into detail.

First, I know you will want to know about "Tristeza," the virus that kills all citrus trees (except the lemon) budded on the Seville or sour orange rootstocks. It is of no importance in South Africa. For many years they have used only immune rootstocks, chiefly the rough lemon. Recently, as in California, there has been a swing over to the sweet orange as a budding stock. Dr. Raimond Marloth, Superintendent of the Subtropical Research Station at Nelspruit, has published several articles in which he has offered evidence that the sweet orange is preferable in many ways to the rough lemon and equally immune to "Tristeza," a Brazilian term that they don't as yet recognize. One reason is that groves on rough lemon rootstock seem to go into a "slow decline" from the 25th year on, somewhat similar apparently to the slow decline in Florida. In contrast, Dr. Marloth gives an instance of a sizeable grove over 25 years of age in the same area on the sweet orange rootstock still in vigorous bearing condition. Carefully checked experiments for over ten years with these and other stocks have confirmed the favorable opinion of the sweet orange rootstock. Trees are slower in coming into production but the quality of the fruit is superior.

But the fly in the ointment is this. Another virus disease has made its appearance in recent years for which there appears to be no immune rootstock nor any immune variety. Dr. Marloth reported about a year ago that all the tangelos and Temples except the Orlando were subject to this disease, called "greening." When I visited the test orchards with Dr. Marloth in June a few fruit of the Orlando were found showing traces of the insidious disease. The serious part of the situation is that before it was realized that this menace existed many thousands of buds and budded trees of practically all their citrus varieties had been distributed far and wide in South Africa. Growers as yet do not seem to realize that there is trouble ahead, many of their trees being as yet rather too young to give evidence of the new virus. The symptoms are this,—small green spots or a single spot appears near the stem end of the fruit, the fruit becomes deformed—smaller than normal in size, insipid in flavor, and inferior in keeping quality. While some of it can be sold locally, it is worthless for overseas shipment,—the market for the great bulk of the South African crop. While South Africa produces only 2 percent of the citrus fruit grown in the world, their shipping time comes when very little is

available from other sources, so that they actually furnish about 50% of the fruit introduced into the European markets.

Besides "greening," there is a "gum pocket" disease also called by the pathologists "bark pitting," that seems somewhat like a form of psorosis especially bad in central Florida on the Orlando tangelo. I visited twice the laboratories ("labcratries") of the Botanist and Pathologists at Pretoria and was shown both macroscopic and microscopic specimens of these diseases. Dr. Phillips, Dr. Dyer, Dr. Anderssen, Dr. McClean, and Mr. Crous were all very cordial. Dr. McClean told me of a virus disease recently appearing in the lime



"Boschfontein," Rustenberg Valley grove of Col. A. H. Guy. Pump house in the foreground. Jacaranda trees grow wild on the "Kopjie" overlooking the grove. Here also were forts used by the Boers in the Boer War days.

groves of the Gold Coast that kills trees in less than a year. He has proved that it is transmitted by an aphis.

I took with me to South Africa, at Dr. Marloth's request, seed of our best tangelos (furnished by the Orlando laboratory and properly treated)—these seed to start new clones or races free from virus. It was, however, obvious that such a new virus-free race would not long remain in that condition unless their entomologists succeeded in discovering the agent of transmittal,—aphis or what-not, and succeeded in eradicating it,—quite a job.

Of course they have the Medfly, which doesn't seem to worry them. They use as a bait spray fluosilicate and a sweetener (white sugar),—fruit kept picked up and buried. But a still worse pest is the so-called "false codling moth." While the Medfly attacks only ripe fruit, the moth attacks fruit in any stage of ripeness. It is not attracted to bait sprays nor to electric light at night. Fruit is kept picked up and picked off and buried deep or immersed in tanks with oil and water. Still they go on planting, with all these handicaps.

One reason perhaps is the tight control maintained by the State through the Coop. Every grower having 300 citrus trees or more becomes a member automatically, and the Coop. disposes of his crop. In one large packing house the fruit was being shipped not only with the brand but with the retail price! —8 for a shilling or 10 for S, according to grade or size,—this to prevent retailers from overcharging their customers.

It was the manager of this huge concern, the Crocodile River Estates, Mr. Esselyn, who pulled out a diary and told me that on December 20, 1920, he and his wife had been entertained at our Terra Ceia home, and he had visited the Manatee groves with me. Incidentally, nearly every man that I met connected with the citrus industry had been to America and knew most of our research men quite well.

The Crocodile River Estates has a well equipped research laboratory, Dr. Kriel in charge, where all their problems are investigated with modern methods. They are quite familiar with the need sometimes of nutritional sprays and use zinc sulphate quite regularly. In a few instances iron has been found beneficial, and also boron. I was surprised to find that practically all their citrus soils are mildly acid, and lime is being used in many places, especially where it is desired to use legumes as cover crops. This is necessary with lucerne or alfalfa which serves the double purpose of gathering nitrogen and deeply penetrating the soil with its extensive root system.

Besides citrus, the Crocodile River Estates grow avocados, mangos, papayas, lychees,

guavas, and large quantities of vegetables. There are about 40,000 lychee trees in the Valley, all propagated from two Mauritius seedlings introduced about 50 years ago. The largest of these two seedlings had a spread of about 60 feet and a height of 40 ft. They were anxious to learn of Col. Grove's improved method of air layering using Vitafilm. This company employs about 1,00 natives and has about as many bullocks. A few of the latter are used as oxen but their main use is to feed their native workers. The latter get 2 shillings a day in cash (about 40c) plus rations and quarters. It amounts to about £4 a month, or about 15 to 16 dollars. A modern hospital is provided for the sick and injured. A careful check is kept on calories and vitamins to make sure their human workers are in fit condition for their work. Beer brewed on the premises is doled out on Saturday night.

Some other orchard crops have been given a trial. Pecans have not proved promising. Tung oil groves (both *Aleurites Fordi* and *A. Montana*) have been a total failure.

Returning to citrus, the orange was brought into South Africa in 1644 from the Island of St. Helena. It was a surprise to find some old varieties such as "Mediterranean sweet" and "Du Roi," long ago abandoned in Florida, being grown in a small way. They give some trouble from splitting,—one reason for their being given up in Florida. The Valencia constitutes 55 percent of the commercial plantings, 40 percent being navels, and 5% miscellaneous. Of all citrus, 85 percent are orange, 12 percent grapefruit, 2 percent lemons, and 1 percent "naartzies," or tangerines. Considering that their main market is overseas, 8,000 miles away (1,000 by rail), it perhaps is quite fortunate that their fruit has a thick, tough peel. The standards of sugar content, 6½% solids, is quite low according to our ideas. The use of arsenic on oranges is permitted but limited to a small percentage of the acreage not to exceed 10 percent. This is done to spread the shipping season. Fruits given the arsenic spray must pass a test of 8½% solids.

A bag of netting holding 30 lbs. of fruit is called a "pocket." Two and a third pockets are about equivalent to a packed case of 80 lbs. Their estimates on the crop are usually expressed in "pockets" even though the overseas fruit is packed in wooden cases much like the California crate. They expect to export 10 million pockets this year, equal to 3½ to 4 million packed cases. This is about 10% more than the previous year. In other seasons the Coop, has been able to sell the overseas crop at a fixed price in England, but under the present government such an arrangement did not prove possible. The head of the Coop.,

Premier Estates grove, Southern Rhodesia. Tall eucalyptus trees used as windbreak, grove uncultivated for 12 years. Contour planting is now generally being adopted.

Dr. Winston Allright, went to England recently to try to arrange for the disposal of this year's crop. Dr. Allright happens to be a distant cousin of our own Mr. John R. Winston.

In the "pack houses" (packinghouses) I visited I looked over their crate material or "box shook." All of it was imported—from Brazil, U. S., Sweden, Portugal, and Spain. Many millions of Eucalyptus trees are being grown but they all go "underground," used as mine props. The wood is not suitable for crate making. My nephew, a Government Forester in Southern Rhodesia, is preparing soon to remedy this situation. He is growing, in several extensive Reserves which I visited, many thousands of pine seedlings,—species from our own southern states and one species from Mexico. No house in So. Africa is ever built of wood,—only brick or stone is used and seldom more than one story high. I photographed the only wooden house I saw in 5 months' travel, and it was a recently built *log house*. Things will be different, I believe, in another decade or two. My nephew, by the way, got much of his early horticultural training in Florida while visiting at Terra Ceia, enough to decide him to be a forester.

Nothing has been said about another citrus area of growing importance, the grove plantings of Southern Rhodesia. The best known and oldest grove is an extensive one known as The Premier Estates. The manager, Mr. Perrott, has grown up on the farm and has some original ideas. He showed me one block of trees that for 12 years had not been cultivated—trees in excellent condition and producing a good crop of fruit. When an old grove is removed he practices a rotation,—2 years in grass, 3 years in "Sunn Hemp," 5 years in alfalfa, then replant to citrus. He can carry out such a program as the farm embraces large areas devoted to maize, wheat, oats, and pasture for a large herd of cattle. This citrus area seems to be free from the new virus disease, "greening." Much of their orange grove is planted to the "Premier orange," a Jaffa seedling resembling the Jaffa orange grown in Florida. It is a fine eating orange. The Mediterranean Sweet is also liked and still being planted. Most of their fruit can be sold locally or sent further north without resorting to the overseas market.

Another extensive citrus area that I planned to visit was that known as Sundays River, including the Amanzi Estates. This area is in the Cape Colony and benefits from its proximity to the Indian Ocean. On the Atlantic side in the same latitude, it is too cold for commercial citrus growing. An untimely illness prevented my visiting this interesting region. Those of you who have access to the South African Citrus Grower will learn a good deal about this region. The Grower is owned and edited by Mr. and Mrs. J. Mackie Niven, owners of the Amanzi Estates. The Nivens visited the citrus growing section of the United States about a year ago. Mrs. Niven is a daughter of Sir Percy Fitzpatrick, author of the famous book "Jock of the Bushveld." On our way to the great game reserve, the Kruger National Park, we traveled along the road paralleling the Sabi River which marks the trek of Sir Percy. This road is now being properly marked by the State and preserved as a monument to the memory of a great pioneer.

The opportunity to see so much of South Africa and the citrus districts was made possible by our brother-in-law and genial host, Col. A. H. Guy, himself a citrus grower and a prominent industrialist and philanthropist. Though a very busy man he spent weeks taking us about and showing us points of interest. The visit to the Kruger National Park is a story in itself. His familiarity with the region made it possible for us to see and photograph more of the big game animals than less fortunate visitors see after weeks of repeated visits. Dr. Marloth told of an experiment that was started in a citrus grove not far from the Game Reserve. The experiment was rudely interrupted by an invasion of elephants and hippos destroying some of the trees. No doubt the green foliage tasted good.

Everywhere we were received with the greatest courtesy and altogether it was a wonderful trip.

PANEL ON PESTICIDES

W. Mercer Rowe, Jr.

Tampa

We recognize that no subject is as important both for the present and the near future in our national affairs as this subject of the food supply of the world, and our ability to share our fortunate position as producers of this food with the more unfortunate peoples of the world who are in such dire need of rehabilitation after the tragic events of the last few years. American farm history is a series of cases in which a new pest appeared, spread and devastated, and finally was brought under control more or less by some chemical.

Next to weather conditions and soil fertility, insects and plant diseases are the most important natural factors affecting crops. Pests can destroy unprotected crops. Unless a farmer controls pests and plant diseases, he may lose his investment in land, seed, fertilizer and labor. It is estimated by the B. E. P. Q. that the annual loss caused by insects alone in the United States is approximately 4 billion dollars.

Pest control is a science. The production, distribution, marketing and use of pesticides is a part of pest control. Continuing success will depend upon using scientific knowledge and sound business judgment. Coordination of these two principles will insure reasonable and continuous profits to manufacturers and farmers, and contribute to the economic stability of our country and the world by aiding in effective production and protection of essential food, feed and fibre crops.

This panel on pesticides has been developed with three major thoughts in mind.

1. Importance of pesticides to growers.
2. Research with pesticides by experiment stations.
3. Industry's role in the development of pesticides.
4. Summary and review of work to date in Florida on Food and Drug Administration hearings.

THE IMPORTANCE OF PESTICIDES TO THE CITRUS INDUSTRY

Howard A. Thulberry

Lake Wales

For many years the principal Pesticides used by the Citrus Industry were: (1) Sulphur in its various forms, for the control of mites. (2) Oil in the control of scale, whitefly, mealy bugs and red spiders. (3) Copper as a fungicide for melanose and scab control. (4) Nicotine Sulphate for the control of aphids.

In many instances these were found to be inadequate for the best control but as the Industry knew nothing better, it did the best it could with them.

If a severe infestation of pumpkin bugs occurred in a grove the only way to get rid of them was to pick them from the trees by hand. Many dollars were often spent trying to control aphids with Nicotine Sulphate with poor results. Poor results were obtained trying to control purple and six spotted mites with Sulphur when it was not advisable to spray with oil. The use of oil was never satisfactory in the control of mealy bugs and much damage often resulted even after a costly oil spray had been applied. There has always been many objections to the use of oil in the control of scale insects.

These are only a few examples of the inadequacies of the Pesticide formerly used by the Citrus Industry.

About ten years ago DN was introduced for the control of red spiders. After sufficient experiments were carried on by our research agencies, they recommend this material and it has been used quite successfully in the control of these pests.

With World War II came D. D. T. and while it has never found a place in the Citrus Industry except for the control of the fire ant,

it was the forerunner of many organic compound pesticide which followed in its wake, the principal ones of which are:

1. Benzene Hexachloride for the control of pumpkin bugs, grasshoppers and aphids on non-bearing trees.

2. Chlordane for the control of pumpkin bugs, grasshoppers and ants.

3. Toxaphene for the control of pumpkin bugs and grasshoppers.

4. Tetraethylpyrophosphate (TEPP) for the control of aphids. The latter three materials being used on both bearing and non-bearing trees.

5. Parathion for the control of red and purple scale, snow scale, cottony cushion scale, mealy bugs and aphids.

While all of these new pesticides are very important in the control of citrus pests, Parathion or some similar material has the possibility of becoming the most important of them all.

A few of the reasons are as follows:

1. Parathion is compatible with most other materials as long as the mixture is not highly alkaline, thus enabling it to be used in combination sprays, thereby saving a spray application.

2. According to information to date Parathion can be used at any time without damage to the trees or fruit, therefore trees can be sprayed before becoming heavily infested with scale.

3. Spraying heavily scale infested trees with Parathion results in much less dead wood than when sprayed with oil.

4. Spraying trees with Parathion does not have the depressing effect that occurs in spraying with oil, therefore giving a more vigorous tree that should give higher yields.

5. Spraying with Parathion does not affect the coloring of fruit. In a commercial operation this year, the Parathion sprayed crop of grapefruit reached 100% color in 42 hours in the coloring room while grapefruit from oil sprayed groves were only 60% colored after 66 hours.

6. Spraying with Parathion does not lower solids in fruit as does spraying with oil.

For these and many other reasons, Parathion, or some similar material, as a pesticide seems to have the possibility of being the answer to the Citrus Industry's prayer.

We have heard the reports here in this meeting of the results obtained in experiments made by the research agencies on these new pesticides. We congratulate these agencies on the fine work they have done on all the new materials which have come to them so rapidly. We also congratulate the Pesticide Industry upon making these materials available.

However, Parathion is a poisonous material. Deaths have occurred through its use. Perhaps these were due partly to ignorance in handling, partly to carelessness, but it would seem that before it can be generally used by the Industry that the pesticide Industry has the responsibility of finding the answers to many questions yet unanswered regarding the safe use of this wonderful material. I am sure the Pesticides Industry has already accepted this responsibility and will soon be in a position to give the industry those answers.

The Citrus Industry also has its responsibility in regards to these poisonous pesticides. Recommended poundages should be adhered to in all cases. Let us not go on the theory so often used that if a little does good, more should do better. Directions and precautions as to the safe application of the material should be followed to the letter. Employees should be trained as to its use.

The fact that processors in this state have processed many tons of the 95% technical grade of Parathion without a single casualty is proof that this material can be handled without injury provided proper precautions are taken.

The Citrus Industry needs this pesticide. Let us not lose it by our own carelessness.

IMPORTANCE OF PESTICIDES TO GROWERS OF FLORIDA VEGETABLE CROPS

JOFFRE C. DAVID

Economic Counselor of the Florida Fruit & Vegetable Association

Orlando

In the few minutes alloted me I shall attempt to draw you a simple word sketch of the problem presented by insects in our vegetable crops, and some of the economics surrounding the control of this type of pest.

To give you the proper perspective of the situation facing us, I will go back to some of our basic geographical factors. You will remember that the world is divided into three temperature belts—the torrid, the temperate, and the frigid.

In the torrid zone—and Florida is on the rim of it—man has been fighting insects for countless generations, not to mention the many other battles he has waged against various types of micro-organisms that have tried to devour him and many of the things he produced.

In the temperate and in the frigid zones, man has had the advantage over most insects.

In the tropics some of you may have seen the battle being waged. Some twenty-five years ago, and until recently, only partial crops of the more hardy types of vegetables could be raised in tropical areas. Yield was very poor and quality most inferior. This was before the advent of our newest insecticides. These crops were raised principally in the high valleys (above 3,500 feet) where more temperate conditions, freer from insects, existed; or in small plots where they could be hand-tended. Of course, the greater abundance of birds in these areas was of material benefit in keeping small plots free of insects so long as the insects lasted—after which, the birds were the problem.

Coming back to Florida, which has many of the tropical disadvantages so far as pests are concerned, you can readily see the number of economic problems encountered in bringing better than a quarter of a million acres of commercial truck crops into successful production each year.

Confining ourselves to the insect problem, you can imagine the tremendous job and cost it would be to hand-dust or spray with crude materials some 80,000 acres of beans; 15,000 acres of cabbage; 12,000 acres of celery; 16,000 acres of cucumbers; 4,000 acres of eggplant; 13,000 acres of green peppers; 25,000 acres of Irish potatoes; 35,000 acres of tomatoes; 10,000 of squash; and 12,000 of sweet corn, etc.—not to mention 50,000 acres of watermelons which you may not choose to put in the vegetable class.

The effectiveness of our newest insecticides applied with modern machinery—including the airplane—has played a large part in making possible the continued successful production of our vegetable crops for northern winter consumption in the face of great increases in costs such as labor, transportation, and others.

It is true that some of the newer insecticides now in use are suspected, and some are known, to be highly toxic to warm-blooded animals. . . . So were some of our older ones. All insecticides or pesticides, as you may wish to call them, are poisonous; having varying degrees of toxicity.

In connection with this it is well to point out that the vegetable deal in Florida is one which came into existence when refrigerated transportation made possible the delivery of off-season vegetables to northern consumers. In that time growers and the various allied agencies connected with the production of these crops have accumulated considerable experience in the proper use of insecticides, and will continue to make further progress as new materials and practices are developed.

In view of the extensive use of insecticides we must make here in Florida in order to produce our crops, it is well to keep in mind a few important economic factors surrounding

the successful production of our vegetable crops:

1. There are a number of crops which we could not produce economically without effective pesticides—sweet corn is one of these.

2. Other costs of production being as high as they are—yield and quality are at a premium. These cannot be attained without adequate pesticides.

3. The actual cost of insect control as a factor of production requires that the product used be efficient as well as effective. There are large increments of labor, machine time, etc., connected with the application of these products.

4. Also, in the best interest of soil preservation, it is important that the insecticide used do the job without ill effect upon the soil. Some of the older insecticides, such as arsenate of lead, presented a distinct problem in many instances.

5. Also of importance, in the opinion of growers, is that there be the opportunity of a choice of insecticides to suit their particular needs.

THE ROLE OF THE CITRUS EXPERIMENT STATION ENTOMOLOGISTS IN THE DEVELOPMENT OF NEW INSECTICIDES

J. T. Griffith, Jr.

Citrus Experiment Station

Lake Alfred

During the few years since the close of World War II there has been a veritable revolution in the insecticide industry. Prior to the war it was only occasionally that a new insecticide appeared on the market, and in those days there was adequate time to check and test it thoroughly before it was offered to the grower. However, since the war years there has been a flood of new materials. Extravagant claims are made for some of them and in many cases these extravagant claims are actually justified. This places us in a position where we have to decide which one may be of some use to us on citrus since we cannot work with all. These few selected materials have to be tested in order to find out how they may fit into the citrus spray program. Because of the publicity that is attached to many of them, it often becomes difficult to prevent them from getting into the hands of growers before adequate tests have been performed, and in some instances a new insecticide has been offered for sale before adequate information concerning its toxicology and pharmacology has been ascertained. Although we feel at the Citrus Station that we are in an excellent position to find out how a new material can be used on citrus and the place that it may have in the citrus spray program, we are not in a position to determine the toxicological and pharmacological aspects of the insecticide, nor are we in an adequate position to give information to the grower so that his spray hands and those men handling the sprays or dusts may be adequately protected. If I may be permitted to look into the future for a moment, it would appear to me that this situation may grow worse instead of better. More and more materials are making their appearance on the market. In my opinion something should be done to remedy this situation which threatens to become intolerable before too many years pass. I have neither the time nor is this the place to discuss the ways and means of promoting such a program, but I believe it possible to suggest here that by adequate labeling laws and by enlargment of some of our already existing facilities we would be able to delay the introduction of new materials and prevent them from being

•Most of the work on parathion at the Citrus Experiment Station has been performed under the direction of Mr. W. L. Thompson.

placed on sale until such time as complete and satisfactory information regarding their use has been obtained.

As an example of what we can be expected to do with a new insecticide at the Citrus Experiment Station I want to use our recent development of parathion* as an example. Initially I want to take the opportunity to commend the American Cyanamid Company for proceeding with this material as they have. They have done extensive work in toxicology and pharmacology of the material and this information has been given to entomologists throughout the country. They have done as good a job as I believe we can reasonably expect industry to do under the present setup which we have. Needless to say some of the information which we require on the use of this material is still lacking. Until such time as it is obtained, we must expect to go slow with parathion.

When a new material is given to us at the Citrus Experiment Station a number of different types of experiments are laid out. First, we try to determine how much is needed to kill the insect involved. At the end of two years we now have a clear picture of the amount of parathion necessary to control scale insects. As dosage is worked out, however, many other problems arise. We must find out about timing. When is the material most effectively applied? Does temperature or humidity affect the efficiency of the material? Is the stage in which we find our scale insects important? Could it be possible to apply low dosages two or three times a year and have a more effective scale control program than if we applied a single large dosage at one time? These are questions which take not one, but several years to answer. We are now only beginning to get into some of these aspects.

At the same time that dosage trials are under way, tests are made to determine the compatibility of the insecticide with other spray materials. We want to know if it can be mixed with such things as zinc, copper, sulfur, etc. We have to find out whether it can be used in alkaline mixtures. These combinations must also be examined for phytotoxicity of any kind.

Another phase of work which goes along with these studies is one concerned with spray residues. Our insecticide chemist, Mr. C. R. Stearns, gathers leaf samples in order to determine how long the material remains on the tree and whether any of it is actually absorbed into the leaf. After sufficient tests he is able to determine how long we will expect to have residues of the insecticide on the trees. This study must be carried even farther. We must find out whether residues stay on the fruit, whether any insecticide is absorbed into the fruit, and whether or not it may contaminate the juice.

We are now in a position at the Citrus Station to thoroughly investigate the problems connected with canning and by-products*. Fruit can be not only made up into single strength juice, but can also be checked as frozen concentrate. Different types of juice extractors can be used and they can be set with different pressures so that different amounts of peel oil and other peel extractives may be included in the juice product. The final samples can be analyzed for parathion and taste tests will be run to determine if any off flavors have been imparted into the canned product or to the fresh juice.

As can readily be seen after possibly two or three years work, we can be in a relatively good position to announce to the citrus industry how much of the material to use, when to use it, what to mix with it, and whether or not under any circumstances it will have any deleterious effect upon the canning or fresh fruit qualities of the fruit. The unfortunate thing is that although all of this work has been done, we may still not be in a position to recommend the material for use on citrus. This arises from the fact that we are not in a position to undertake work concerning the toxicology and pharmacology of the material. In my own personal opinion this work should be done by the basic manufacturer of the

*Canning plant and by-product research is under the direction of Dr. F. W. Wenzel

insecticide before it is released for public consumption. It should be so performed that the material is not allowed to come on the market until such time as completely adequate precautions can be issued for its use. We should know something of the action of the material as a toxicant in the human body. We should know how the men filling tanks and spraying with it should handle it in the field. We should know under what conditions we may expect toxic symptoms to occur and we should know what to do about it if and when they do occur. If all of these things are known we can use a very deadly poison without anyone being hurt. Until they are known, it is hazardous to use any new material.

In closing I want to suggest that some mechanism is needed for slowing up the introduction of new insecticides to the consumer. The entomologist needs ample time to test the material in order to see how it can best be used on the crop with which he is concerned. At the same time he needs to have access to toxicological and pharmacological data which will allow him to issue satisfactory precautions for use of the material. It is desirable that we be in position to know for sure whether or not this material will adulterate the food product and subsequently whether or not it would be liable to seizure by the Pure Food and Drug Administration. In other words I believe that workable tolerances should be set at an early date so that the entomologists and the consuming public know what they are dealing with. After these steps have been taken, then the material can be released and can be used with a minimum possibility of danger to any of the consuming public or to the growers who are producing the fruit. I feel rather strongly that steps should be taken in this direction. Exactly what those specific steps are and how they should be taken remains for another discussion.

FIELD RESEARCH WITH PESTICIDES FOR VEGETABLES

NORMAN C. HAYSLIP

Belle Glade

It would be rather easy and quite impressive to outline a method by which our present day pesticides should be tested and let it go at that. However, to do so would by no means be an honest expression of the way our long list of new chemicals are tested, and most certainly would not stand the cross examination which might follow this discussion. It should be made clear at this point that any statements made apply only to the speaker, and any resemblance to methods used by other economic entomologists is purely coincidental.

Situated as we are at the Everglades Station in the heart of an important vegetable industry, we are very conscious of the growers insect problems and it is our responsibility to arrange research programs in such a way as to help the farmers stay in business as far as insects are concerned. Our major efforts are directed toward developing economical and practical ways and means of reducing insect losses. Our problems may be arbitrarily divided into four categories:

1. Crops and insects for which satisfactory control measures have been developed.
2. Crops and insects for which "stop gap" control measures have been developed, but which are not entirely satisfactory due to excessive cost of treatment, or inadequate control, etc.
3. Crops and insects for which no control is known.
4. New crops and insects which are constantly appearing.

I believe that the most of the major insect problems will fall into the first two categories, however, an uncomfortable number would undoubtedly drop into the third "unknown" grouping, and I can see no hope of ever eliminating category No. 4 without horticulturists and farmers anxiety to plant new crops and

with the bugs increasing ability for travel and gnawing yen for variety in their diet.

Those insect problems which are responsible for the greatest loss, or are potential threats to the industry receive priority in our research program. Since new serious problems arise practically every season our program must remain flexible enough to deal with emergencies as they arise. In order to cope with the numerous problems, the economic entomologist is forced to make shortcuts and compromises in experimental procedure or be lost in the tidal wave of new insecticides, new crops and new insects.

Trusting that this background will to some extent explain our ignorance and perhaps cultivate a sympathetic understanding, the way new pesticides are tested will be discussed.

News of a new insecticide reaches us through technical journals, trade magazines and letters or visits from members of the research staff of the manufacturer. In many cases the chemical has already been investigated in routine biological assay and the approximate dosage established for a limited number of insects. If the formulation seems to have promise in our area samples are obtained from the manufacturer. Various techniques of testing insecticides are used, however, the most common methods used at the Everglades Station may be listed in four general groupings.

1. *"Spot-Trials"*—These are usually small unreplicated plots often consisting of a few plants in single row plantings on our regular testing grounds. Other spot trials are made on commercial farms. This method of testing is often used when a new insecticide is first received. As many different crops and insects as can be located are treated in very small plots with a rather heavy application of the material. The treated plants are visited frequently for the next few days for observations on insect mortality and plant tolerance. Spot trials in the permanent plots on the Station grounds are usually applied once each week and periodical observations are made.

2. *Replicated experiments*—These are carefully planned experiments usually made on experiment station plots. Only those insecticides which have shown promise in the spot trials, or have obtained good results in other areas are included. These experiments are usually for the purpose of comparison of different insecticides and dosage rates. Treatments are made with hand dusters and an estate type power sprayer at regular intervals throughout the growing season. Insect counts are made in all plots and yields are often taken. Replicated experiments are also established in cooperation with growers where established insect infestations are found.

3. *Field trials*—After a new insecticide has been rather thoroughly investigated in spot trials and replicated experiments it is then tested in field trials on commercial farms in cooperation with the grower and is compared with his standard treatment.

4. The fourth and final test is made by the grower who begins using the treatment. While this phase of the test should logically come last that is not always the case. Often the grower will adopt a practice or insecticide before it is thoroughly investigated. Frequent visits to farms where the new pesticides are being used provides information on its commercial use.

This discussion would not be complete without listing some of the things which should be learned about a new pesticide before it is finally recommended for use. First, we should learn which insects are controlled and how the applications should be made. Second, the effect of the insecticide upon the yield and quality of the crop should be determined. Third, the precautions necessary in handling, applying and the possibility of a toxic residue on edible parts of the crop must be understood. Fourth the compatibility of the pesticide with other insecticides, fungicides and nutrients should be determined.

Since we are seldom in a position to develop all of the phases of the problem to our satisfaction before the pesticides are adopted by growers we rarely make recommendations on new pesticides, but only offer suggestions concerning their use.

INDUSTRY'S ROLE IN DEVELOPMENT OF PESTICIDES

R. H. F. DADE

Jacksonville

The introduction of the so-called synthetic organics into the pest control field has greatly increased the number of industries directly or indirectly concerned with the production of insecticides. Some thirty years ago when I entered the insecticide field in Florida there were not more than a dozen items of insecticides and fungicides of economic importance. Most of these materials reached the grower in the package of the basic producer. Labeling procedure was simple. We knew the crops on which to use 2, 3 or 4 pounds of Lead Arsenate to a hundred gallons. We had residue tolerance for various crops, and the spray hands knew Lead Arsenate and Nicotine were poison and Oil Emulsion was not.

Practically none of the present day organics is of value as an insecticide or fungicide in its basic chemical state. We think of DDT as an insecticide, but it is valueless to the farmer until it has been processed into usable form.

Some basic producers go through all the processes and market products ready for use by the farmer. Others take only one step from the basic chemicals and process them into concentrates for use by blenders, while many other chemical producers make only the basic material and leave the processing responsibility up to others.

The insecticide industry, as a whole, has been very careful about introducing new materials on a broad scale. The usual procedure was to carry a new product through laboratory and greenhouse tests then field tests on a fairly broad scale, limited sale under supervision and finally general sale.

DDT was about the first of the new insecticides, followed closely by BHC. These products require a lot of Chlorine and Chlorine producers naturally became interested, and developed many other chlorinated hydrocarbons in their research work. The phosphate esters interested another group of chemical producers, and the numerous organic fungicides still another. Today, therefore, we have a wide variety of industries doing tremendous amounts of research having a direct bearing on the insecticide and fungicide industry.

Experiment stations, Federal Scientific workers and research staffs of commercial companies are coming up daily with new uses and improved variations of older materials, completely new pesticides and certain combinations which show promise. Progressive growers haunt these people to learn what is new. Often these growers find out where the new promising material can be obtained and launch a full-scale use before production is out of the pilot plant stage. If results look good other manufacturers get on the band wagon and away we go.

I think that Parathion, with which most of you are familiar, is a concrete example. Not much publicity was given this product by its major producer. It was known to be very poisonous, but it was hoped that ways of processing and using could be developed so it could be handled with reasonable safety. The first warnings about DDT were to be extremely careful in handling. In fact, for nearly a year after it was released for agricultural uses, major insecticides manufacturers sold it only for use under close supervision. Nobody got hurt, so when growers were told that Parathion was poisonous, many thought it was another case of being over cautious. A demand for Parathion products swept the country—and the world.

It is only human nature for producers and processors to supply this existing demand if they have the material, and plenty is available.

There seems to be no great residue problem with Parathion as it breaks down fairly rapidly and apparently is not cumulative in the human system. The problem is in field use and in processing plants.

As I mentioned previously the insecticide industry today embraces many other industries, which a few years ago, we did not consider even remotely connected with insecticides. Most of these manufacturers today are concerning themselves with insecticide problems, even though in many cases they produce only the raw chemicals. This cooperation through dissemination of information extends down to the final blender and in some cases clear to the grower. However, the grower looks to the man whose name is on the package, and in the case of most formulations, he is the local dust blender. This man has a great responsibility to see that his formulations are properly labeled, securely packed and adequate precautions are given in the case of hazardous materials. The grower also has a responsibility to his spray or dust crews, and to the public which consumes his product. He should find out the minimum dosage of a pesticide to give desired results and keep to this. Excessive residues can thus often be avoided. He should not take a chance with applications of poisonous materials later than recommended. I have known growers to use DDT on cabbage a few days before cutting, when it is definitely prohibited after heads begin to form. He should not use a material which has definitely been prohibited in certain cases. The spraying of dairy cattle with DDT is a case in point. It is still being done, although cattle growers are warned that DDT accumulates in the fat and shows up in milk.

Finally, in the case of hazardous materials the grower should see that his spray hands are instructed in handling and provided with any necessary devices to reduce the hazard to a minimum.

No group can consider itself entirely blameless in the premature sale and improper use of the new materials. However, by close cooperation, we shall be able to take advantage of these wonderful new pesticides with a minimum of hazard to anyone. If we don't, we're likely to find ourselves back in the old Bordeaux Mixture and Lead Arsenate days.

AN INTERPRETATION OF THE CAUSE OF RESISTANCE TO WETTING IN FLORIDA SOILS

I. W. WANDER,

Citrus Experiment Station,

Lake Alfred

The inability to readily wet soils which have been planted to citrus, especially through the ridge district, has been recognized for many years. This phenomenon is also to be found in gardens, lawns and noncultivated areas and is not confined to groves. This resistance to wetting varies in degree and is usually greatest in an uncultivated area such as found under a tree, although often middles which have been thoroughly cultivated exhibit considerable water repellency. Several reports[2,3,5] have discussed this property but little information is available regarding a cause or reason for these sandy soils to be water repellent. Since maximum utilization of irrigation or rainfall is dependent on uniform distribution of water through the soil it is important to understand and correctly evaluate this phenomenon.

During the rainy seasons of the past three years, 1947, 1948 and 1949, differences in the amounts of water repellent soil were noted in a group of plots of grapefruit which had received different fertilizer treatments for the past 10 years. The relative amounts of water repellent soil were estimated by placing a drop of distilled water on soil samples taken from beneath trees and observing the time required for absorption. This was done by taking samples to a six inch depth with a stainless steel tube 1 inch in diameter, turning the sample tube upside down and placing the drop of water on the exposed soil surface. If the drop of water did not soak into the soil within 10 seconds, the soil was listed as water repellent, and, vice versa, easy to wet. Eighty ex-

aminations were made in each plot and the results from duplicate plots combined. The results of this investigation are shown in Table 1. These results indicate that fertilizer practices influence the amount of water-repellent soil found under field conditions.

It is known that fatty acids form very insoluble soaps with calcium, magnesium and other bi and trivalent metals and that these soaps, when dry, are extremely water-repellent. Waksman[6] had previously cited the presence of fatty acids, fats and waxes in soils. With this in mind, several composite soil samples which exhibited the water-repellent property were checked for the presence of fatty acids. This was done by heating the soil in the presence of a strong sodium hydroxide solution, neutralizing with sulphuric acid and steam distilling in the presence of a slight excess of acid. A small amount of material was obtained which gave a test for a carboxylic acid group[4].

A dilute ether solution of the material obtained from the above steam distillation, when added to subsoil, which wet very easily, had no effect on its wettability. However, when a dilute aqueous solution of calcium or magnesium hydroxide was added to the soil which had been previously treated with the ether extract, the soil, when dry, became very water-repellent.

This was further checked by treating an easily wetted soil with a dilute solution of stearic acid in ether. The ether was evaporated, then a dilute solution of either calcium or magnesium hydroxide was added and the soil dried. Following this treatment the soil became extremely water repellent. Evidently the formation under field conditions of metallic soaps results in water-repellent soil and a similar water-repellency can be produced in the laboratory by similar chemical combinations.

Jacobson and Holmes[1] found that metallic soaps, such as magnesium stearate, are practically insoluble in ether, but that magnesium stearate is relatively soluble in methyl alcohol. Jamison's work[3] indicated that a water-repellent soil, extracted with ether, remained water-repellent. With these facts in mind a sample of water-repellent soil was extracted first with ether to remove any free fats and waxes, then with methyl alcohol. This treatment left the soil readily wettable. The methyl alcohol extract, when evaporated on an easily-wetted soil, left the soil water-repellent whereas the ether extract had no effect. When a portion of the methyl alcohol extract was evaporated to dryness, nitric and perchloric acids added for destruction of organic matter, and heat applied, small globules of fat were released. Further heat oxidized the fat, and the residue, when taken up in distilled water gave strong magnesium and calcium tests. This indicates that calcium and magnesium soaps had been dissolved by the methyl alcohol. It is probable that the formation of a coating of water

TABLE 1.
EFFECT OF FERTILIZER TREATMENT ON AMOUNT OF WATER REPELLENT SOIL

Plot No.	Fertilizer Treatment	July 1947 Percent Water Repellent Soil	August 1948 Percent Water Repellent Soil	August 1949 Percent Water Repellent Soil
	N—P_2O_5—K_2—Mg0—Mn0—Cu0			
1 & 12	3-6-8-4-1-½—60 lbs.-tree-year 40% N organic source pH controlled to 5.8 with high Ca limestone	23	18	4
2 & 11	3-6-8-0-1-½—60 lbs.-tree-year 100% N inorganic source pH controlled to 5.8 with high Ca limestone	4	1	2
3 & 10	3-6-8-2-1-½—60 lbs. tree-year 100% N inorganic source pH controlled to 5.8 with high Ca limestone	29	30	12
4 & 9	3-6-8-4-1-½—60 lbs.-tree-year 100% N inorganic source pH controlled to 5.8 with high Ca limestone	23	23	8
5 & 8	3-6-8-4-1-½—60 lbs.-tree-year 100% N inorganic source pH not controlled (4.2)	0	1	1
6 & 7	3-6-8-0-0-0—60 lbs. tree-year 100% N inorganic source pH not controlled (4.2)	5	8	3

repellent metallic soap on the soil particles causes the water repellent property found in many Florida soils.

The possible formation of extremely insoluble metallic soaps by zinc, copper and manganese also, presents a problem aside from their possible action as water repellent materials. Both copper and zinc are required in citrus nutrition and their behavior, especially that of zinc, when placed on the soil as fertilizers, might be explained by the fact that insoluble soaps are formed. The effects of such compounds on citrus nutrition may be considerable and should be further investigated.

However, the phenomena of water repellency found in sandy soils used for citrus cannot be construed as being entirely detrimental as far as water relations and nutrition are concerned. Since most of the soils of Florida are very sandy and porous in nature and are subjected to high rainfall, leaching of many nutrient elements is quite rapid. By having some degree of water repellency such a property can be considered as an asset, since it helps prevent rapid leaching of essential nutrients. In cases where water repellent soil has developed to an extreme degree, wettability can be helped by hoeing or mixing the soil and by adding large amounts of finely divided materials as has been previously cited.[2,7]

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PLANT QUARANTINE ENFORCEMENT FROM A CUSTOMS VIEWPOINT

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I am not a practical farmer, nor have I been educated in horticulture and agriculture. However, having been in close contact with the plant quarantine work since 1915 and knowing many of the officials and inspectors personally over a long period of years, I have learned of the many problems confronting the organization in the enforcement of the plant quarantine laws and in the protection of our horticultural and agricultural interests.

Before entering into the discussion which is the subject of this paper, I believe a brief resume of the duties of the Customs Service and its relation to the enforcement of the quarantine laws may be of interest.

The Customs Service is a branch of the Treasury Department and one of the oldest services of the government. It is charged with the collection of duties imposed by the Tariff Act as modified by trade agreements on merchandise imported from foreign countries; in preventing the introduction of articles made by convict, forced or indentured labor; of treasonable, obscene or lascivious articles, pictures, books or prints; of gold and silver which may be falsely or fraudulently marked; of articles bearing trade marks or trade names without the consent of the trade mark owners; of copyrighted books without the consent of the copyright owners; of viruses and serums except from institutions duly licensed; of wild animals, insect pests and birds except under permit; of plant products from infested countries or except under permit; of livestock from countries infected with rinderpest or foot and mouth disease; of the plumage or parts of wild birds; of seal skins taken in other than treaty waters; of opium and narcotic drugs; of counterfeit coins, obligations or securities, domestic or foreign.

This Service is also charged with the en-

forcement of the neutrality laws; controls or prevents the exportation of arms and ammunition and strategic materials as proclaimed by the president and the Office of International Trade; and the importation and exportation of gold and silver except in conformity with presidential authority. The Customs Service acts as an enforcement agency in the prevention of the smuggling of merchandise into the United States and the sanitary requirements of the Public Health Service in connection with vessels and aircraft arriving from foreign countries.

In the performance of these duties the baggage of passengers arriving from foreign countries is examined; all vessels and aircraft engaged in foreign commerce are searched and required to enter and clear at the custom house, reporting their cargoes and paying certain tonnage taxes and fees. The merchandise which forms the cargoes of such vessels and planes must be entered and duty paid thereon before release or bonds given for the security of such payment.

The collector of customs grants marine documents authorizing vessels to engage in foreign and domestic commerce and is the recorder of bills of sale, mortgages, hypothecations and liens involving American vessels. As a recorder his acts are comparable to those of a recorder of deeds of real property; he maintains similar records and issues certificates of record of title which resemble and serve the same purpose as an abstract on real property.

Prior to the passage of the Income Tax Act of 1916, the Customs Service was primarily a collecting agency and duties on importations were the major source of revenue of the United States. Since the passage of the income tax law, the revenues derived from customs duties have been small in comparison with the total revenue of the United States. For the last fiscal year approximately $450 million was collected from customs duties.

Thus it will be seen that the original functions of the Customs Service have materially changed. While it is still a collection agency, its most important functions are of an enforcement nature.

The organization of the Customs Service consists of the Bureau headquarters at Washington and a field service. The United States and its insular possessions for administrative purposes are divided into 46 collection districts, which include one in Alaska, one in Hawaii and one in Puerto Rico. These districts usually embrace one state although on the Mexican and Canadian borders states may be divided into several collection districts and in the interior several states are embraced in a single customs collection district. On the seaboard, generally each state is a customs collection district.

The administrative affairs of each district are supervised by a collector of customs appointed by the president by and with the consent of the senate. District No. 18 embraces all of the waters, shores and territory of the state of Florida including the northern bank of the St. Mary's River. There are 15 ports of entry in this state, to wit, Fernandina, Jacksonville, St. Augustine, West Palm Beach, Port Everglades, Miami, Key West, Boca Grande, St. Petersburg, Tampa, Apalachicola, Carabelle, Port St. Joe, Panama City and Pensacola, the headquarters office being at Tampa where the collector resides.

Honorable Boyce A. Williams of Leesburg, Florida, is the present collector for the Florida district. He is a long-time resident of this state, is a large grove owner, has had considerable governmental experience, and I am quite sure is known to many of you. He is vitally interested in the welfare of Florida and in the protection of our agricultural and horticultural interests. It is with his consent and at his request that this paper is being written.

One of the most important preventive duties performed by Customs is the enforcement of the Plant Quarantine Act of 1912, as amended. While representatives of the Department of Agriculture have the authority by law to board and search vessels, because foreign commerce is controlled generally by customs, it was early realized that effective enforcement of the federal and state plant quarantines depended in a large measure on the close cooperation of customs and plant quarantine officers.

Florida, by reason of its geographical location, is especially exposed to invasion by tropi-

cal plant pests. It is but a short distance to the Bahamas, Cuba and other West Indian Islands and the South and Central American countries where plant pests exist which are not prevalent in our country. The climate of Florida is similar to that of these countries, and pests transplanted to Florida indeed thrive, better in fact than in the country of habitat since natural enemies are not present during the early stages of any infestation.

Systematic methods of protection of our agriculture and horticulture are of comparatively recent origin, and unfortunately many pests and diseases had been imported or introduced into this country before the Congress realized the conditions existing and passed the federal Quarantine act of August 20, 1912.

This act, as amended, among other things permits the Secretary of Agriculture to gather information concerning the existence of pests and plant diseases in foreign countries and the several states of the union including territories and possessions of the United States; to issue quarantines against localities for the several types of materials which may be hosts for such insects and diseases. It also provides a system for the prevention of the introduction of infested plant material and the submission of all plant material if necessary to personnel qualified and experienced in agricultural and horticultural affairs before release thereof from customs custody.

Recognizing the necessity of supplementing the efforts of the federal government and because of the appearance of citrus canker in this state, the Florida legislature passed the Plant Quarantine Act on April 30, 1915. This law was amended in 1927 to conform to certain decisions of the Supreme Court but no startling or revolutionary changes were made.

Shortly after the passage of the Plant Quarantine Act of 1915, Dr. J. H. Montgomery was appointed in charge of the Quarantine Section of the State Plant Board under Dr. Wilmon A. Newall, the Plant Commissioner. These gentlemen concluded that adequate enforcement could be attained only by the state employment of quarantine inspectors who would enforce the state quarantines and collaborate with the Department of Agriculture in the enforcement of the federal plant quarantines.

Both Drs. Montgomery and Newall were practical men, well versed in the science of agriculture and horticulture. Great care was exercised in the selection of the quarantine inspectors. Many were graduates of agricultural colleges having special knowledge of plant pests and diseases prevalent in Florida with experience in citrus canker and similar work. All received technical training after employment. The qualifications for employment were high. In addition to the technical essentials, the inspectors were required to be of such a temperament as to be capable of dealing with the traveling public generally, ships' officers and crews, transportation employees, and customs and immigration officers.

Frequent conferences were held by Drs. Newall and Montgomery with customs officers and representatives of the Department of Agriculture, and close cooperation has always existed in Florida between these services.

Since Customs must examine arriving baggage, board and search vessels and examine stores, most of the actual examination work has been performed by officers of the Customs. However, representatives of the State Plant Board or the Department of Agriculture are always present at the baggage examinations, the searches of ships, etc., and plant material which may be found by customs officers is turned over to the quarantine inspectors for examination.

The two organizations have indeed worked harmoniously together. Plant Board inspectors are housed in federal buildings in space usually furnished by collectors of customs. They board ships and planes with the customs authorities and the two forces work together in all inspectional activities. On numerous occasions attempts to smuggle prohibited material, at times infested with destructive plant pests, have been frustrated by the vigilance of customs inspectors and port patrol officers. On the other hand, violations of the customs laws have been detected and reported by Plant Board inspectors.

Indeed one may well say that the keynote of these two organizations has been, "They best can work who best agree."

There are four principal means of introducing plant material into the United States from foreign countries:

1. Regular importations—that is, shipments made by freight and express and arriving by surface craft or aircraft.

The interception of infested or infected material is comparatively simple in these cases. In addition to the filing of a customs entry describing the material, its value, quantity and the duty thereon, a permit for the importation of plant products issued by the Secretary of Agriculture must be filed with the Collector of Customs. Packages are opened by customs officials and examinations made to determine whether the contents, value, weight and measure agree with the description appearing on the entry. Plant quarantine officials are present and if the plant products are admissible release thereof is accomplished.

Infested material is either destroyed or fumigated by quarantine inspectors. Because of the great increase in the importation of plant material at Florida ports, the Federal Department of Agriculture some two years ago established a fumigation station at Miami similar to the one existing in Hackensack, New Jersey. It is now possible for certain types of plants and plant products, including seeds, to be imported under permit, subject to fumigation at Miami. Previously such importations were required to be forwarded to Hackensack, New Jersey.

Customs officers note carefully the packing surrounding the merchandise and if of certain types delay delivery until such packing is passed by Quarantine officers. This is an important function since the pink boll weevil has been found in packing arriving from China while foot and mouth disease may be and probably has been transmitted by straw used in the packing of merchandise imported into the United States.

2. Importations through the foreign mails.

Enforcement on importations by this means is fully covered and is effective. Mail packages are examined by customs officers and plant material found is turned over to the proper employee for inspection, destruction, fumigation or return to the mail.

3. Sea stores.

Most of the sea stores subject to the Plant Quarantine Act carried by watercraft consist of staples such as rice, corn, yams, potatoes, green coffee, etc. The number of interceptions of plant material from stores, however, while smaller than in the case of baggage are large in economic importance. For example, the bean weevil, the yam weevil, and the bean pod borer, as well as other pests, have been discovered in vessels' stores.

At a port outside of Florida, a number of active Mediterranean fruit fly larvae were found in fresh tomatoes contained in the vessel's stores.

Stores on aircraft at present have not presented a real enforcement problem since most of the meals are supplied by caterers at designated points and consist of cooked food. It is probable with the inauguration of non-stop flights and the installation of refrigeration on planes, uncooked fruits and vegetables may be carried in these stores. In fact, in some of the so-called "luxury" planes refrigeration facilities have been installed and rare and out-of-season foods, fresh fruit in particular, have been found. The risk of introduction of major plant pests by this means is illustrated by the interception at Miami of live Mediterranean fruit fly larvae on six different occasions in fresh peaches, oranges and tangerines carried as stores by Spanish airliners. Various fruitfly, *Anestrephe* species have been intercepted in mangoes from Puerto Rico and citrus fruits from the Argentine and Brazil in airplane stores.

The size and passenger capacity of aircraft engaged in international transportation is ever expanding. This will result in more non-stop flights direct from infested or infected territory and the carriage of larger supplies of food and stores, much under refrigeration. The increase in speed and carrying capacity of the freight liners is another threat to our agriculture. Material may be plucked in the field in the morning and arrive in Florida in the afternoon. Pineapples, avocados, okra, tomatoes, eggplants, and other vegetables from the West Indies and Central and South American countries are regularly transported through Florida ports as are cut flowers, orchid plants

and ornamental shrubbery. The airplane has not only revolutionized transportation of passengers and cargo but has facilitated the introduction of pests and diseases harmful to our agriculture. As the non-stop flights increase in number, this menace will become greater.

4. Baggage of Passengers and Crew.

Perhaps the greatest problem of enforcement occurs with articles arriving from foreign ports in passengers' and crews' baggage. As stated before, to avoid duplication of effort, in Florida the examination of foreign material for all purposes is conducted by the Customs officers. Plant quarantine inspectors are on duty in the baggage examination rooms and many fruits, vegetables, plant material, seeds or other forms of plant life found by the Customs inspectors are delivered to the Quarantine employees. Customs and Plant Quarantine afford twenty-four hour service at the Miami International Airport. At other airports and piers where surface craft dock, Customs and Quarantine officers afford service outside of the regular office hours of 8 a. m. to 5 p. m. in emergencies and as the necessities of the service require.

Certain types of immigrants on arriving in the United States almost invariably have some form of plant life, fruit or vegetables in their baggage, clothing, or on their persons. One wonders at the ingenuity displayed in the attempt to import this material into the United States by this means. Fruits, vegetables, cuttings, plants, and nursery stock have been found concealed in the pockets of overcoats and women's coats; the pockets and linings of dresses and coats; and false bottom suitcases. All sorts of schemes are evoked with the hope that such material will be passed without detection.

During a recent examination at Miami a Jamaican negress presented an incomplete baggage declaration. Her luggage consisted of 15 or 20 suitcases, boxes, bags and paper packages; also she carried three coats on her arm. The passenger declared a small quantity of liquor, some food stuff and miscellaneous inexpensive articles which she claimed were intended as gifts to relatives in New York. As she appeared to be ignorant, inexperienced and somewhat simple, the Customs inspector endeavored to assist her by giving full instructions. Believing she had not intended to violate the law, he permitted the amendment of her declaration to cover excess liquor and food stuffs. Examination disclosed the presence of *some* mangoes and prohibited plant material in each of the packages, which material was, of course, confiscated. After the completion of the examination and as the passenger approached the exit, she caught up a coat from an adjacent bench. The port patrol officer on duty at the exit noticed this movement, searched the coat, and six mangoes were found tied in the sleeves.

A similar incident occurred with an American citizen. After their baggage had been examined, a man and his wife, well dressed and carefully groomed, approached the exit. The port patrol officer on duty noted that the sleeves of the woman's coat which she carried on her arm had been carefully fastened with string. Believing that some contraband was contained therein and noticing a slight movement in the sleeves, the officer cut the strings and to his surprise some ten or twelve love birds escaped into the baggage examination room. The husband, whether aware of his wife's transgressions or not, gave her a cold look and departed from the room leaving her alone with the Customs officers. Little did she know that after the birds had been caught, she only had the option of exporting or destroying them. She chose the latter. Some tropical nursery stock was also found in the lining of the coat.

Another interesting case involved a small box in the possession of a member of the crew of an airplane. The examination was taking place upon the field as a contract plane was involved and no passengers were landing. Opening a small cardboard box approximately eighteen inches in height, the Customs officer thrust in his hand to discover the nature of the contents. He hastily withdrew his hand when he touched a small boa constrictor which was being brought in from Brazil by the crew member as a pet!

At Key West, Customs inspectors discovered a double handful of citrus leaves rolled in a

pair of socks and stuffed into a shoe at the bottom of a barracks bag. These leaves were alive with egg spirals of *Aleurocanthus woglumi Ashby* (citrus blackfly). Another passenger on the same day had spread a layer of lime leaves between two pieces of clothing in a trunk. Only a thorough inspection could have revealed the presence of this plant material.

The necessity for careful examination of all baggage is further evidenced by a seizure made by a Customs officer at Miami recently. Noticing a bulge in the passenger's coat pocket, the officer asked that the contents be displayed. Among the papers and miscellaneous articles usually found in a man's pocket was a single citrus leaf. This leaf contained an egg spiral of the blackfly. Quarantine officers claimed but for the thoroughness of the examination the blackfly might have been introduced into the port of Miami!

The magnitude of the operation so far as the baggage examination is concerned is best evidenced by the following statistics:

During the fiscal year of 1948-1949, Customs and Plant Quarantine inspectors in Florida boarded and searched approximately 20,000 airplanes from 95 countries, carrying 299,194 passengers with 740,627 pieces of baggage. Plant material from 89 countries was intercepted. The number of interceptions aggregated 7,769 or a total or 40,577 units.

The material intercepted consisted principally of tropical and subtropical fruits such as citrus, mangoes, guavas, Surinam cherries, sapodillas, custard apples and other hosts of fruit flies; ornamental plants and cuttings of crotons, hibiscus, oleander, gardenia, etc., and staples such as corn, cotton, rice, sweet potatoes, peas and beans. The most important insects or diseases noted by the quarantine inspectors were fruit flies, including Mediterranean fruit and citrus blackfly, sweet orange scab, lima bean pod borer, California red and many other scale insects.

In addition to the air traffic, these officers boarded and searched 4,398 surface craft bringing in an aggregate of 33,528 passengers. The sea stores of each of these vessels were examined and the craft searched for contraband of all kinds.

During the same period approximately 55,000 mail packages and over 1,000,000 packages of merchandise were examined.

It has been practical for the quarantine officials to handle this vast volume of business because of the close cooperation which has existed between the two services.

* * *

In addition to the duties heretofore outlined, the presence of customs and quarantine inspectors is required to enforce quarantines in connection with arrivals of military and naval aircraft at MacDill Field (Tampa), Boca Chica Field (Key West) and the Municipal Airport (Jacksonville). It is not sufficient that the law be explained and orders issued by competent authority against the importation of plants and similar material into the United States without a permit. Actual examination of the plane and the presence of officers alone will ensure a compliance with the law. The following incident illustrates this point. During the war some difficulty had been experienced at one of the army airfields in securing notices of arrival of planes from foreign ports. A conference was held by army, customs and plant quarantine officers. The commanding officer of the airfield, being sympathetic to the enforcement, issued strict orders against the placing of any fruit, vegetables or nursery stock on aircraft of the armed forces, including the Transport Service. He was confident that this would rectify the situation. However, on the next arrival of the plane which brought this commanding officer back to the United States, citrus fruit containing fruit fly larvae was discovered in the stores of said plane.

The statement has been made that the advent of air transportation has greatly increased the danger of the introduction of plant pests and diseases into our country. To refute this statement it has been pointed out by the airlines that the inside of the plane is sprayed by the Public Health Service immediately upon the discharge of the passengers after arrival in the United States. The Public Health Service at Miami, however, has discovered clusters of moth eggs attached to the outside of the wings, fuselage and propellers of planes

arriving at that port. Investigation discloses that in most cases these planes have remained on a field for a material length of time without operating, say for two to ten days. Approximately one million eggs have been accounted for to date. They consist of three different species of the moth family. One hundred egg clusters were found attached to the outside of the wings of an army plane arriving from the Dominican Republic. These clusters actually hatched while United States Public Health Service inspectors were watching and thousands of caterpillars dropped down on the grass beneath the plane. These were the larvae of the fall army worm.

The infiltration of moth eggs is of great interest as it offers a new means of transporting insects into the United States. It has been noted that the eggs are not laid on the wings where motor oil streaks appear. The problem might be solved by spraying the surface of aircraft with a light film of oil if such is practical.

It seems next to impossible to educate the traveling public and certain transportation officials to the fact that insects, plant pests and diseases dangerous to our agriculture and horticulture may be introduced through the importation of small quantities of nursery stock and fresh fruits brought in for personal use. The city dweller knows little of the problems of the farmer or the horticulturist and does not understand that the ornamental shrub or luscious fruit contained in his baggage may be the avenue of introducing a pest into the United States which will cost millions of dollars to eradicate or even control.

As eternal vigilance is the price of liberty, so alertness, careful inspection and rigid enforcement are the safeguards to the protection of our agricultural interests. We have, however, gone far since 1912. Today agricultural societies have been organized, the farmer has been educated and practically each state has an agriculture department and agents to assist the agriculturist. However, much more must be accomplished. Whether we like it or not we are living in one world. The means of transportation are such as to insure the rapid spread of diseases and pests from one locality to another. A partial solution, in the opinion of many informed persons, is that we must treat plant diseases as we have human diseases. When an outbreak occurs in Brazil or in South Africa, trained representatives of the nations having commerce with such countries must give aid and assistance by the contribution of money and knowledge to the infested countries. This is not idealism or altruism; it is selfish, hard common sense.

PROGRESS REPORT ON PARATHION AS AN INSECTICIDE FOR FLORIDA CITRUS

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The status of using parathion on citrus has not been determined as yet. However, many growers are using it for the control of scale and mealybug and the purpose of this report is to inform the industry of the results that have been obtained with this material. Because of the limited space alloted for each paper there is no discussion here on precautionary measures for handling and applying parathion. Instructions for the safe handling and application of parathion can be obtained from the manufacturer or from the supplement attached to the 1950 Spray and Dust Schedule in the Better Fruit Program.

During the 1949 season extensive experimental work has been done with parathion. The different phases of the work included testing various concentrations of parathion; the timing of sprays; compatability of parathion with other spray materials; the effect of parathion on the tree in relation to tree shock, internal fruit quality, and degreening. The results obtained during 1949 substantiated the results reported in 1948[2].

Although parathion was used in the form of a 25 percent wettable powder, amounts of

parathion will be expressed as the equivalent of a 15 percent wettable powder since most of the parathion now being sold in the state is at that concentration. Wettable sulfur at 10 pounds per 100 gallons was added to all sprays containing parathion. The wettable sulfur was included for the control of rust mites and not as a scalicide.

Concentration of Sprays.— In 1948[3] it was reported that a half pound of actual parathion or 3⅓ pounds of the 15 percent wettable powder per 100 gallons would control both purple and Florida red scales, but the results of some experiments indicated that lower amounts might be effective. The results of the past year indicate conclusively that amounts between 1.6 pounds and 2 pounds of the 15 percent parathion will be sufficient. Table 1 presents the results of varying the amount of 15 percent wettable powder from ⅓ of a pound to 3⅓ pounds per 100 gallons as measured by the control of purple and Florida red scales. Slight reductions were obtained with ⅓ of a pound, but as the amount of parathion was increased in units of ⅓ of a pound up to 1⅔ pounds, there was a significant increase of purple scale control with the addition of each unit. Where the amount of parathion was increased from 1⅔ pounds to 3⅓ pounds, there was no material increase in the average control.

In one timing experiment in a grapefruit grove where applications were made each month of the year except during May and June, comparisons of purple scale control were made between concentrations of 1⅔ pounds and 3⅓ pounds. Where 1⅔ pounds were used there was an average control of 89 percent compared to an average control of 92 percent where 3⅓ pounds were used or a difference of only 3 percent. Since the cost of parathion is high, it would not be economical to apply more than 2 pounds per 100 gallons to increase the average control by about 3 percent. It should be pointed out, however, that there was less variation in the degree of control with the higher amounts (See Table 1). The use of parathion is still in the experimental stage, and it may take several years to determine the concentrations best suited for the various programs used. At present it is suggested that 1⅔ to 2 pounds of 15 percent wettable powder be used where one spray per year is to be applied. However, where a light to medium infestation of scale exists it can be checked with 1 pound. One pound of parathion applied in the post-bloom spray and another pound used in the summer time resulted in as satisfactory control as where 2 pounds were used in the summer time. The use of the more dilute sprays will be discussed in more detail under timing.

Florida red scale was controlled with parathion at the same dilutions as was used for purple scale. On an average, the control of Florida red scale with parathion at 1⅔ pounds per 100 gallons was as satisfactory as with an oil emulsion at a concentration of 1.3 percent actual oil.

Snow scale was very effectively controlled with a 15 percent parathion at 1⅔ pounds per 100 gallons. Although no actual counts were made, scale crawlers were hard to find following a parathion-wettable sulfur spray. Where an oil emulsion had been applied the crawlers could be found on many areas on the trunks of the trees. Apparently a better distribution on the trunks of the trees was obtained with parathion than with oil emulsion.

Compatibility of Parathion with Other Spray Materials.—As was reported in 1948[3] it has been found that parathion can be combined in sprays containing most of the materials that are used on citrus. Parathion was combined with wettable sulfur in all sprays applied in 1949 for the combined control of scale insects and rust mites. It was also used in combination with sprays containing one or all of the following materials: compounds of neutral zinc and copper, borax, and DN (40% dinitro-o-cyclohexyl phenol). It was effective in sprays containing zinc sulfate and/or manganese sulfate where a minimum amount of hydrated lime was used to neutralize those materials. Where zinc sulfate was used the hydrated lime was used at a ratio of one part of lime by weight to three parts of zinc sulfate. It does not require as much lime to neutralize man-

ganese sulfate as it does to neutralize zinc sulfate. Therefore, where zinc sulfate and manganese sulfate were used in the same spray, the hydrated lime was added at a ratio of 1.2 pounds to 3 pounds of zinc sulfate and 3 pounds of manganese sulfate or an approximate ratio of 1-5.

The fact that parathion can be safely combined with other materials, especially wettable sulfur and compounds of copper and zinc, makes it a desirable insecticide. Scale infestations may develop at any time of the year, and if any of the various species of scale are numerous during the period when other insecticides and fungicides are necessary, parathion can be included in the spray; for instance, the period of rust mite control was much longer following a post-bloom spray containing neutral copper, wettable sulfur, and parathion than where a combination of a neutral copper plus an oil emulsion was applied for the same purpose.

TABLE 1. CONTROL OF PURPLE SCALE WITH VARYING AMOUNTS OF PARATHION

Number of Experiments	Amount of 15% Stock Per 100 Gal.	Average % Decrease of Infested Leaves	Range Between Minimum and Maximum Decrease
3	.33 lbs.	28	12-43
7	.66 lbs.	57	26-99
14	1.00 lbs.	75	51-99
6	1.33 lbs.	81	36-99
11	1.66 lbs.	89	67-99
26	2.00 lbs.	90	70-99
7	2.66 lbs.	91	77-98
14	3.33 lbs.	92	81-99

TABLE 2. RUST MITE CONTROL IN POST-BLOOM TIMING EXPERIMENT FOR THE CONTROL OF RUST MITE, PURPLE SCALE AND MELANOSE

Spray Dates 1949	Programs: Parathion, Basic Copper and Wettable Sulfur	Programs: Oil Emulsion and Basic Copper
	Percent Infested on June 19	
April 11	28	53
April 26	27	60
May 7	8	65
May 14	4	73
May 26	3	45

Timing in Relation to Scale Control.—The timing of parathion sprays was not so important where the initial kill was considered except during the months of November and December when the initial kill was not as satisfactory as with sprays applied during the other months of the year. There are some indications that parathion is not so effective when applied during cool or cold weather. However, applications made in February resulted in satisfactory initial control under weather conditions that were similar to conditions existing during November and December. Until more information is obtained, it is not recommended that parathion be applied when the temperature is below 70°F.

Timing is important for scale control where only one application is to be made during the year. The longest period of purple scale control was obtained when the applications were made during the period between June 15 and September 15. In 1949, the August applications were the most satisfactory. Trees sprayed between the period of January and April were reinfested by September to about the same degree as they were when the applications were made. These findings are similar to results obtained where oil emulsions have been used. Regardless of the scalicide used, the most satisfactory control for purple scale on a yearly basis has been obtained where the applications were made in June, July or August.

There are certain advantages in applying parathion in two applications. Parathion applications made during the post-bloom period have been very effective in keeping the scale infestations at a low level and preventing the young leaves and fruit from becoming infested. The post-bloom spray is also effective in controlling mealybug infestations before they become severe. In a limited number of timing experiments a post-bloom spray of parathion, 1 pound per 100 gallons, plus a midsummer spray of 1 pound was as effective as 2 pounds applied in one spray during midsummer. In post-bloom sprays parathion was combined with neutral copper, zinc sulfate, hydrated lime, and wettable sulfur. In the summer spray parathion was combined with wettable sulfur. Parathion at one pound per 100 gallons is recommended only where light to medium infestations of scale exists. Where there is a heavy infestation of scale it is ad-

visable to use at least 1¾ to 2 pounds per 100 gallons.

There are some limitations to post-bloom parathion sprays. In Valencia groves or where the grapefruit crop has not been picked, it may not be advisable to apply parathion in the post-bloom spray, since it is during that period when late varieties are being harvested. It is not recommended that a spray containing parathion be applied within 30 days of harvesting because of the possibilities of the pickers being poisoned by parathion. Unless the fruit has been picked before the post-bloom spray is applied it is advisable to apply only the summer spray containing 1¾ to 2 pounds of parathion on late varieties of fruit. The above discussion on timing parathion sprays has been from the standpoint of more or less ideal timing conditions for the spray, but parathion can be applied at almost any time of year if it is necessary to check a heavy infestation of scale. The severity of the scale infestation in any particular grove should determine the type of parathion program to be used.

Timing of Sprays in Relation to Toxicity to Foliage and to Tree Shock.—Parathion has been used for over three years, but up to the present time no apparent shock to sprayed trees has been observed. In the spring of 1949 some injury developed on succulent foliage that had been sprayed with parathion. However, the injury was no more severe than has resulted from sprays containing lime–sulphur or zinc and copper compounds when such sprays were applied on young succulent foliage.

Apparently parathion is not as toxic to trees as oil emulsions. This fact was demonstrated in a tangerine grove where one part of the grove was sprayed with parathion and the other part was sprayed with oil emulsion at 1.2 percent actual oil. Sprays were applied on February 22, 1949 during a period of dry weather. The soil appeared dry but the trees were not in a wilted condition when the sprays were applied. Nine days after the application a record of leaf drop was taken from under 20 trees in each plot. Where parathion was applied there was an average of 3.8 leaves per square yard compared to 39.3 leaves in an equal area where the oil emulsion had been applied. Other observations were made where there was practically no leaf drop following parathion sprays compared to a light to medium drop following an oil emulsion spray in adjacent plots.

Dead wood was of minor importance in all plots sprayed with parathion except where heavy infestations of purple scale had killed the wood before the sprays were applied. The dead wood that was pruned from the trees in one block of oranges was weighed in order to determine the difference in the amount of dead wood which developed under different treatments. All of the trees were heavily infested with purple scale when they were sprayed, which accounted for some of the dead wood in all plots. Where parathion sprays were applied there was less than one-half as much dead wood pruned from the trees as from the oil sprayed trees. (See Table 3). Where comparisons could be made in some commercial groves, there appeared to be less dead wood where parathion had been applied than where oil emulsions had been applied in the same grove.

Timing in Relation to Fruit Color.—Apparently parathion does not retard the degreening of citrus. In 1948[3] it was reported that applications of parathion did not retard degreening of grapefruit. Results of work done in 1949

TABLE 3. AMOUNT OF DEAD WOOD PRUNED FROM TREES SPRAYED WITH PARATHION AND WITH OIL EMULSION. 1948. FIGURES EXPRESS POUNDS OF DEAD WOOD PER TREE

Materials	Spray Dates	Rows	Tree Numbers 1	2	3	4	Rows	Tree Numbers 5	6	7	8	Average
Parathion	June 28	L	10	11	14	16	B	8	10	12	12	11.6
Oil Emulsion	June 28	J	50	24	43	44		15	12	25	20	29.1
Unsprayed Check		H	6	10	18	13	H	19	16	7	4	11.6

Note: Trees pruned during February, 1949. There was a heavy infestation of purple scale when all applications were made except the June 28 oil application on rows K and C.

substantiate the results of last year. In 1949 a series of plots were sprayed with parathion and another series of plots sprayed with an oil emulsion. On October 24 fruit samples were picked from each plot and held in the coloring room for 40 hours. In all cases there was a higher percentage of fruit well to fairly well colored from plots sprayed with parathion than with oil emulsion. (Table 4).

TABLE 4. DEGREENING GRAPEFRUIT WITH ETHYLENE GAS. FRUIT PICKED OCTOBER 24 AND HELD IN THE COLORING ROOM 40 HOURS

Spray Dates	Spray Materials	Figures Expressed in Percent				
		Well Colored	Fairly Well Colored	Slightly Colored	Green	Amount Passing Shipping Grade
	No Treatment	15	70	14	1	85
	No Treatment	24	51	25	0	76
April 15	Parathion	14	72	14	0	86
July 1	Parathion	24	63	3	0	87
July 1	Oil emulsion	13	59	21	7	72
August 15	Parathion	15	59	21	5	74
August 15	Oil emulsion	2	38	41	19	40
September 15	Parathion	14	65	17	4	79
September 15	Oil emulsion	4	61	27	8	65
October 15	Parathion	41	53	6	0	94
October 15	Oil emulsion	9	48	31	12	57

Parathion 15% applied at 1.66 pounds per 100 gallons.
Oil emulsion applied at 1.3% actual oil.

The most significant difference in the degree of coloring between fruit from parathion sprayed trees and oil sprayed trees was from the plots sprayed on October 15. Where parathion had been applied 94 percent of the fruit was well to fairly well colored compared to 57 percent colored from the oil sprayed plots.

Timing in Relation to Internal Fruit Quality.—The production of citrus of high internal quality is the aim of most citrus growers. For many years it has been the desire of the citrus industry to find a scalicide that would not adversely affect the internal quality of citrus fruits. Improper timing of oil emulsion sprays used on citrus has been shown to prevent the formation of the maximum soluble solids content in the juice[1,2]. Other juice characteristics are also affected by oil sprays but the reduced soluble solids content is the most critical. An efficient scalicide without the detrimental effects to fruit quality which result from the use of oil sprays would certainly benefit the citrus grower. Groves which were used for scale control experiments where parathion and oil sprays were applied were also used to follow the effect of these treatments on the internal fruit characteristics. During the past two years, seven different varieties of citrus in eleven different blocks have been analyzed. Results of these studies during both years have shown that the soluble solids content of the orange varieties studied was generally higher where the tree was sprayed with parathion than where they were sprayed with an oil emulsion. To date, there is no indication that the time of application of parathion spray causes any appreciable change in the internal quality of the fruit. These results are in sharp contrast to those from oil sprays, the latter preventing the attainment of maximum soluble solids content when they were applied much later than the middle of July. Comparisons of applications of oil and parathion spray applied at different times and in varying amounts on Excelsior grapefruit have also been made. Results of these treatments have been less consistent than those obtained from similar treatments on oranges. During the 1948-49 season there was no appreciable difference between any of the oil or parathion treatments. Differences were observed during the 1949-50 season, and grapefruit produced by trees sprayed with parathion had a higher soluble solids content than that produced by trees sprayed with 1.3

percent oil emulsion. Differences in soluble solids content of the juice in favor of the parathion treatments averaged approximately .5° Brix.

From the experiments conducted in 1949 there has been no evidence of detrimental effects to internal quality as a result of the use of parathion sprays. Since there is no adverse effect on fruit quality, it would appear that the timing of parathion sprays may be more nearly regulated to give optimum scale control.

Reinfestation of Scale Insects and Mites Following Parathion Sprays.—At the present time there has been no indication that abnormal infestation of scale insects follows sprays containing parathion. In three different blocks parathion has been sprayed on the same tree for two years. Where either an oil emulsion or parathion was applied in 1948, the reinfestation of purple scale and Florida red scale in 1949 had developed to about the same degree regardless of the materials used. However, there are some indications that purple mites become more numerous following parathion sprays than where it was omitted.

Conclusions

Purple scale and Florida red scale infestations were reduced on an average of 89 and 90 percent with 1⅜ pounds to 2 pounds of a 15 percent parathion material per 100 gallons compared to an average of 92 percent reduction with 3⅛ pounds which indicates that the smaller amounts are sufficient to control the two species of scale most commonly found on citrus. A satisfactory initial control was obtained during any month of the year except November and December, but the most satisfactory time to control scale with one application was during the summer months.

There were no indications that parathion sprays caused any shock to the trees in that no excessive leaf drop occurred and no abnormal amount of dead wood developed following sprays that were applied where the trees were in a weakened condition resulting from a heavy infestation of purple scale or where the applications were made during periods of dry weather. Parathion sprays did not adversely affect the internal quality or retard the coloring of grapefruit and oranges.

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MODERN QUARANTINE PROBLEMS IN FLORIDA CITRUS

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Florida and its citrus industry have grown up. It was but a few years ago when a small Florida industry was riding along in the wake of a much larger California industry and was well isolated from contact with other citrus areas due to poor transportation. Today things have changed, and the struggling citrus industry of the early 1900's has become the major citrus industry of the United States, and the relatively isolated Florida citrus area has become a clearing point for travel. In contrast to the train travel on slow trains without air conditioning that took five days to go to California, you can now leave Tampa in mid-morning and be in New Orleans in 2½ hours, in the Texas citrus area, or in California by evening. Even in my limited time in Florida, I can remember when a car trip to New Orleans was practically high adventure but today drivers take off almost casually for California or Texas and Florida growers visiting in either area are commonplace.

This visiting by citrus growers is a fine thing, and it leads to a great broadening of knowledge about other areas and a better understanding of their problems and our own

problems as well. The unfortunate thing is that it carries with it a certain very definite hazard because bugs can ride in cars and airplanes and air conditioned trains on the same schedules that carry people. At times, people may even connive at their transportation without realizing the hazard that they are entailing upon the citrus industry. In the early days we imported many varieties of citrus from various places on the globe, but these importations always involved extensive study and preparation. It was no casual matter to bring budwood or plant material from distant areas in a satisfactory condition so that it could be propagated in Florida and, consequently, the number of introductions was relatively small. Yet in spite of the fact that only more or less expert people were handling these importations, we managed to import canker and probably most of our other major citrus diseases and insects from other areas because apparently very few of them were native to Florida. With the better realization of the hazards involved we have laid down quarantines to reduce this hazard by prohibiting importation of citrus plant material, such as bud sticks or potted plants from other areas of the world. Today the problem has become the casual, though illegal, bringing in of material by people who see something interesting while visiting another area or the incidental transportation of insects in various types of transportation. Probably our greatest hazard today lies in the bringing in of bud sticks from other areas by unthinking people who might cut them casually in California, Texas, Cuba, or some more distant point, wrap them in a bit of wax paper and bring them in in their pockets, not with the idea of deliberately eluding the law but with little or no understanding of the problems that may be involved. It is difficult for a citrus fancier to realize that a stick of budwood from an apparently healthy and vigorous tree having no visible lesions might harbor the quick decline virus that could wipe out our sour orange stock groves in the matter of a few years.

We should remember at this time that while we have built up the world's greatest citrus industry, at the same time we have opened the doors to things that may prove to be tremendous hazards. The same transportation that lets us visit distant areas with so much ease can also help us to bring in immigrant insects and diseases which could wreak havoc within our citrus industry. What these things can mean is evidenced by the fact that the tristeza virus presumably was brought from Australia to Argentina in citrus nursery stock budded on rough lemon stock and several million trees on sour orange stock were wiped out within the space of about 15 years. However it was brought to Brazil, it did an equally efficient job there. Experiences like this point up the hazards, and they are not the only ones. Black fly brought from the Orient put Cuba out of the citrus business for a number of years until it was brought under control. Citrus canker also brought in from the Orient, wreaked havoc in our own citrus area, and the oriental fruit fly brought in from the Orient to Hawaii is now wrecking much of their horticultural industry.

With this changing situation it behooves us to revalue our own situation. I want, in a dispassionate way, to review the diseases and insects which lie without our boundaries but which could easily be brought into this state in the form of live insects moving by the normal means of transportation, such as planes, boats or trains or which may be brought in by travelers who do not realize the importance of their importation to the future of the citrus industry.

The Louisiana area can probably be omitted from this discussion as it has the same diseases and insects in general that we have here. It does represent a point of danger, however, because of the possibility of importation of insects and diseases and their establishment there entirely too close to us.

The Rio Grande Valley in Texas has a number of diseases and insects that we do not have here. Rio Grande gummosis, the cause of which is not known, is a type of gum disease or wood decay that we do not have here and which has caused tremendous damage in the Valley and is going to be a big factor in the

rate of recovery of groves damaged by the freeze of the past spring. In addition they have the Morelos or Mexican fruit fly (*Anastrepha ludens* (Loew)) at certain times of the year, and larvae of this might be imported in fruit brought from Texas or adults might conceivably come in by car or plane. This insect has been controlled in Texas by cleaning up all host fruits when it migrates in from Mexico during the spring, thus attaining a host-free period. This would not be possible in Florida, and it might do much more damage here than it has ever done in Texas. Also, they have the true California red scale (*Aonidiella aurantii* (Mask.) and on this point I wish to make some remarks. It has been the assumption for many years that we have in Florida the California red scale and that it does not thrive due to climatic conditions. Recent studies along this line, however, indicate that what we have is the yellow scale which is much easier to control than the California red scale and presents much less of a hazard. Our looking into this matter was occasioned by the fact that we found that California red scale when brought into Argentina thrived enormously in a climate almost identical with ours and was much more difficult to control than Florida red or purple scale, both of which were present there. In fact as many as four or five oil emulsion sprays applied in one year failed to give control; whereas, one or two oil applications gave control of the other scale insects without difficulty. Until this matter is further examined here to see whether we actually have the California red scale and it is being controlled by biological factors, or, whether we have only the yellow scale we had better be careful about California red scale and consider it a potential enemy. They also have in Texas a leaf hopper that appears to be giving increasing trouble and probably some strains of Psorosis not present in Florida.

Across the border and into Mexico about 100 miles, you find the black fly (*Aleurocanthus woglumi* (Ashby)) which is now spreading in the direction of the Texas citrus area. While the Mexican government is maintaining quarantine stations along the roads and trying to delay its spread and while the U. S. D. A. maintains quarantine inspection on the bridges crossing the river, the fact remains that once the insect has gotten into border towns like Matamoras and Reynosa wind drift would probably carry it into Texas. The parasites and predators which have effectively controlled the black fly in Cuba have failed in this area, and the spread of the insect has been rapid and its net effect is to put groves out of production shortly after they become infested. It had been our belief that the parasites which controlled black fly so successfully in Cuba would probably work in Florida if we ever got the fly established here, but the failure of these parasites in Mexico throws doubt on this assumption. Travelers going further into Mexico would find the Mediterranean fruitfly (*Ceratitis capitata* (Wied.)) and possibly some insects and diseases that are not here listed and with which we are not yet familiar.

Passing on to California we find Quick Decline which may or may not be the same as Tristeza, but which in any event would have disastrous effect upon trees budded on sour orange in Florida. This disease is caused by a virus, and bud sticks or plants would be the prime method of importation and these bud sticks would not necessarily have to come from trees on sour orange stock but might come from infected though apparently healthy trees on sweet orange or some other tolerant stock. The tendency of growers to believe that any tree that appears healthy, is healthy, does not hold in this case because trees on other stocks than sour orange become infected but show no visible effects of the disease. In addition to Quick Decline there is California red scale subject to the remarks that have already been made concerning it; several types of mites, including the bud mite (*Aceria sheldoni* (Ewing)) which causes deformed fruits and leaves and which is difficult to control; some strains of Psorosis that we do not have and which are extremely virulent and a leaf hopper that causes a green spotting of the fruit. A nonstop plane hop across the Pacific from California is the Oriental fruit fly (*Dacus dorsalis*)

which is causing enormous damage in Hawaii. It is much more virulent and destructive than the Mediterranean fruit fly and California is extending every effort to keep it out and we hope they are successful.

Turning to the south of Florida, we have Cuba very close at hand. A few years ago it was an overnight boat trip, and the boats ran on regular schedules and quarantine inspection could be careful and thorough. Now, Cuba is just a short flight away by plane, a little over two hours from Tampa or one hour from Miami. The result is that enormous numbers of people are making the trip to Cuba and, with improved roads in the island as well as plane service to various points of interest, they are traveling more in Cuba than they ever did before. In Cuba, we have the black fly, previously mentioned, though at present it is well controlled by parasites imported through the cooperation of the State Plant Board of Florida and the U. S. Department of Agriculture with the Cuban government. Also, they have some species of the West Indian fruit fly and in addition a few less publicized things, one of which is the blue-green beetle which causes damage on fruit very similar to damage caused by katydids and grasshoppers and results in much disfiguration of the fruit. There is also a moth (*Gonodonta* sp.) which has a proboscis so tough that it can pierce the rind of an orange and which occasionally, finding its natural food short, invades citrus groves puncturing the rind of the fruit and causing them to leak out their juices. This moth is found damaging citrus at various times in the West Indian Islands, but Cuba is the closest point where it has been a problem.

Just south of Cuba is the island of Jamaica which is a favored winter resort area for many of our people and which is just a short airplane flight from Florida. There we have the Fiddler beetle which is a relative of the Fuller's rose weevil and which attacks not only the foliage of the trees but also eats the bark off the roots. This makes it necessary for most of the grove owners in Jamaica to keep the dirt pulled away from the crown roots of citrus trees out to the spread of the branches in order to confine the ravages of this insect to the smaller roots, so that the trees will not be killed.

Dropping a little further, we arrive at South America where so many of our people are visiting at the present time. There we have a lot of insects and diseases which we have reason to fear and which might conceivably be brought in by the methods of transportation now in use, either by the travelers themselves or as insects carried within the body of the plane or in crevices in its covering. Tristeza, about which a good deal has been written in the last few years and which has caused the loss of millions of trees in Argentina and Brazil, is known to be in Argentina, Uruguay, Paraguay and Brazil. Recent correspondence and contact indicates that it is quite probably in Colombia. From here it can come up through Central America into Mexico or be transported by relatively slow stages or more likely in an innocent appearing piece of budwood in some travelers pocket. In both Argentina and Brazil we have the California red scale, and in Argentina the Delta scale (*Mesolecanium deltae*). Lepra Explosiva which may be the same as our old enemy scaly bark, a form of canker which may or may not be the same as the citrus canker that we have eradicated in this state; several mites which cause severe damage to citrus but which have not been reported here; blind pocket which apparently was brought from South Africa or Australia to Argentina and Brazil; sweet orange scab which causes the same sort of damage to oranges that lemon scab causes to grapefruit; stem pitting and Xyloporosis.

I want to make a point here that up until recently Argentina had quite a free importation of citrus nursery stock and budwood. As a result they have brought in a great many things and these have become established and are making the growing of citrus very difficult in that country. The tristeza virus and California red scale and possibly blind pocket and stem pitting were probably brought in in nursery stock purchased in Australia or possibly in nursery stock purchased in South Africa. The nursery stock was in the main on rough lemon but this did not prevent the trees

from being infected with the tristeza virus even though they showed no effect and wherever these trees were planted, tristeza rapidly wiped out the neighboring trees on sour orange stock. California red scale, known there as Australia red scale because it came in with the Australian nursery stock, has gone all over the Argentine citrus belt and has become a terrific problem because the methods of control that they have at their disposal and which have been successful with Florida red and purple scales have been complete failures in most citrus groves. The canker which they have there and which they call Cancrosis B and which primarily attacks lemons but occasionally attacks oranges was probably imported also. The black citrus aphid (*Aphis citricidus* (Kirk.)) which transmits the tristeza virus was probably brought in on some shipments from the Orient. The Mediterranean fruit fly has recently spread into other than citrus growing areas through importations of infested fruit from Brazil and is becoming a major problem throughout the fruit growing area of Argentina. While a great many people have objected vigorously to the strict restraints placed on the importation of fruits, nursery stock and budwood by the State Plant Board, what can happen when these restraints are let down is readily visible in Argentina which has been free until recently of such quarantine restrictions and where nursery stock has been imported from all over the world and almost all of the world's citrus pests with it.

South Africa and Australia are far away and not on easy airline communicationes. Apparently the diseases which they have, such as tristeza, blind pocket, etc., have already been transported to South America where they are much closer at hand as far as transportation and travel are concerned. We have relatively little information about the present distribution of insects and diseases in the Mediterranean areas, but apparently they are about the same as ours with the exception of Mal Secco. Also, airlines going to and from that area come in at the northern ports and the chances of transportation are not as easy as they would be from South American countries.

This has not been an attempt to be a complete, highly accurate survey of the diseases and insects in various countries. I have tried to mention only in the short time at my disposal some of the most important ones that I have had a chance to observe in other countries and which I believe might thrive in Florida. It is not an attempt to arouse fear or panic among citrus growers here, but rather to give them some picture of what is going on in the way of insect and disease problems in other citrus areas which are so close to us by plane now that you can reach them quicker than we used to be able to go from Gainesville to Ocala in bad weather. The old ideas about boundaries and quarantine are rapidly passing away. If we are to protect ourselves, the growers themselves must think about these problems and by word of mouth educate others to realize the hazards of carelessness in bringing in budwood and other plant material. The problem is no longer strictly a problem for the Bureau of Plant Quarantine and the Florida State Plant Board. There is no way within the bounds of ordinary financing that every road in West Florida from California, Texas and Louisiana could be policed. There are simply too many roads and too many byways. The growers of Florida themselves must become alert to the difficulties of the situation and educate their thoughtless neighbors. The Plant Quarantine agencies are doing a magnificent job and if the growers did as well we would be relatively safe.

PARATHION RESIDUES ON CITRUS FOLIAGE AND IN THE PEEL OF ORANGES

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The use of parathion for the control of scale insects presents some very important problems which should be pointed out to the ones who are going to use this material. The material is toxic to human beings. It is quite volatile and penetrates into the peel of the fruits upon which it is applied. The data presented below were collected from a series of different experments. They emphasize the fact that parathion is quite volatile and that it definitely is absorbed into the peel layers of the fruit.

Parathion Residues on Foliage

Two experiments concerned with the rate at which parathion volatizes off of leaf surfaces are reported below. In one experiment the spray was applied on October 1, 1948, and in the other the spray was applied November 1, 1948. The parathion was used at the rate of 2 pounds of a 15 percent wettable material per 100 gallons of spray, and this was combined with wettable sulfur at the rate of 10 pounds per 100 gallons. Parathion residues were determined as soon as the spray had dried and at 24 hour intervals thereafter. The October experiment was discontinued after 4 days due to rain, but the November experiment was continued through 5 days before rain fell.

The results as indicated in Table 1 show that parathion is quite volatile and that apparently temperature plays a rather important part in the rate at which it is volatilized from leaf surfaces. During October the maximum and minimum temperatures averaged much higher than during November. Approximately 90 percent of the parathion residue was lost during 72 hours in October while in November it required 96 hours to attain approximately the same loss. There were no recordings made on air movement which would also probably play a part in this volatility. However, it is believed that the type of weather was similar except for the temperatures. The results indicate that rather high concentrations of parathion vapors may be present in the grove during several days following the application, and it might be advisable for one to stay out of the grove for that period of time.

TABLE 1—LOSS OF PARATHION RESIDUES FROM CITRUS FOLIAGE AS AFFECTED BY TEMPERATURE

Days Following Application	October, 1948			November, 1948		
	Percent Loss	Temperature Max.	Temperature Min.	Percent Loss	Temperature Max.	Temperature Min.
1	68	85	73	42	75	57
2	85	86	69	58	74	60
3	91	80	70	73	77	61
4	Rain	81	71	90	93	—67
5		----		Rain	Rain	Rain

Effect of Timing of Spray Applications Upon Parathion Absorption Into the Peel

An experiment was designed to study the parathion residues resulting from sprays applied at different times with respect to size of fruit when sprayed. A Pineapple orange block at the Citrus Experiment Station was divided into 10 sets of plots which were sprayed at different times. The fruits were calipered before being sprayed. A rate of application of 2 pounds of 15 percent wettable parathion per 100 gallons was used throughout the experiment. The analyses of the peel were not made until the fruit was nearly mature.

The results as shown in Table 2 indicate that the size of the fruit when sprayed affects the amount of parathion which is absorbed by the peel. No parathion was found in the peel of fruits which were less than ½ inch in diameter when sprayed. Only a trace of parathion was found in the peel of fruits which were sprayed when the fruits were ½ inch in diameter, while maximum amounts were found when the fruits were ¾ of an inch or larger in diameter when sprayed. The results indicate that if parathion is to be applied in the "melanose" or "post-bloom" spray, the spray should

be applied before the fruit reaches an average diameter of ½ an inch.

Effect of Repeated Applications of Parathion on Peel Absorption

The timing plots in the Pineapple orange block at the Citrus Experiment Station were resprayed on November 15, 1949, with parathion. The plots sprayed March 2, 1949, and May 7, 1949, were resprayed with 2 pounds of 15 percent parathion while those sprayed March 31, 1949, and May 14, 1949, were resprayed with 1⅓ pounds of 15 percent parathion. The fruits were analyzed on November 24, 1949.

TABLE 2. EFFECT OF SIZE OF FRUIT WHEN SPRAYED UPON THE ABSORPTION OF PARATHION INTO PEEL OF PINEAPPLE ORANGES *

Ave. Diameter of Fruit	Date Applied	Date Sampled	P.P.M. Parathion	
			Peel	Whole Fruit Wt.
Full Bloom	Mar. 2, 1949	Sept. 28, 1949	0.00	0.00
	Mar. 24, 1949	Sept. 28, 1949	0.00	0.00
⅛ inch	Mar. 31, 1949	Sept. 28, 1949	0.00	0.00
¼ inch	April 11, 1949	Sept. 28, 1949	0.00	0.00
½ inch	April 26, 1949	Sept. 28, 1949	Trace	.....
¾ inch	May 7, 1949	Sept. 28, 1949	0.90	0.16
1 inch	May 14, 1949	Sept. 28, 1949	.60	0.14
1¼ inches	May 26, 1949	Sept. 28, 1949	1.01	0.23
1½ inches	June 9, 1949	Sept. 28, 1949	0.90	0.20
1¾ inches	June 23, 1949	Sept. 28, 1949	0.75	0.16
2 inches	July 12, 1949	Sept. 28, 1949	1.16	0.28

*Two pounds of 15% parathion per 100 gallons were applied.

The results as indicated in Table 3 show that where no parathion had been previously absorbed from the early sprays, the amount of parathion in the peel after the second spray was about one-half as high as the amount of parathion found in the peel of fruits which had absorbed parathion when sprayed earlier. Both results are high because the fruit was analyzed only 9 days following the second application. Generally the parathion will gradually come back out of the peel during a 3 to 5 week period following the application and remain at a stable level until the fruit is picked. This would indicate that if a second application of parathion is to be applied in the early fall on early oranges or grapefruit, it should be applied at least 30 days before harvest.

Summary

Parathion does not remain on citrus foliage for any length of time. As a result of this volatility there may be high concentrations of parathion vapor in a grove for a few days following spray application and it would be advisable to stay out of the grove.

The size of the fruit when sprayed definitely affects the amount of parathion found in the peel of mature fruits. No parathion was found in fruits which were smaller than ½ inch in diameter when sprayed, while a trace is found in fruits which averaged ½ inch in diamater when sprayed. Maximum amounts can be expected when fruits which are ¾ of an inch in diameter and larger are sprayed.

Two parathion sprays will increase the amount of parathion found in the peel of mature fruit and if a fall application is to be applied it should be made at least 30 days prior to harvest.

TABLE 3. EFFECT OF PARATHION SPRAYS UPON THE AMOUNT OF PARATHION IN THE PEEL OF ORANGES PREVIOUSLY SPRAYED WITH 2 POUNDS OF PARATHION/100 GALLONS AT EARLIER TIMING DATES *

Early Spray Date	Sept. 28, 1949 P.P.M. Parathion in Peel	Pounds of 15% Parathion/100 Gals.	Nov. 24, 1949 P.P.M. Parathion	
			Peel	Whole Fruit
March 2, 1949	None	2	1.57	0.32
March 31, 1949	None	1 1/3	1.31	0.25
May 7, 1949	0.90	2	2.92	0.55
May 14, 1949	0.60	1 1/3	1.87	0.34

Second parathion spray applied on November 15, 1949.

PROGRESS TOWARD A BETTER VITICULTURE FOR WARM CLIMATES

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It is my intention in this paper to offer a condensed resume of the broader aspects of fourteen years breeding work with grapes. Rather than to attempt to deal with the matter in a technical way, which would not be practical in such a brief discussion, I will try to offer some of the background viewpoints and angles of approach that have constiuted the foundation of my work.

At the outset it might be well to explain a few pertinent facts whose clear understanding is necessary to a correct interpretation. In the first place it should be emphasized that all of this effort was conducted within and for regions that are essentially tropical in nature. The project was first started in extreme south Florida. It was later carried to Puerto Rico and for the past six years was conducted in tropical Costa Rica, Central America, just ten degrees north of the equator.

The basic aim was to develop, from the wild grape species of the tropical jungle, a class of high quality vineyard varieties that would be well adapted to cultivation in humid tropical climates.

One might naturally ask what connection this could have with the problems of viticulture in the semi-tropical climate of north central Florida. My answer to this would be, that notwithstanding the fact that this part of Florida does not classify as tropical its climatic reaction on plants and crop behavior leans closer to the torrid than to the temperate zone. Full acceptance of this I feel might help to solve many of our more perplexing crop problems.

While on the subject of climate it might be well to discuss a few viewpoints which in the writer's belief have received far too little consideration in warm climate horticulture. There seems to be a natural human tendency whenever a crop has failed consistently, to question the soil or the cultural practice. We have seldom investigated the effect on our planting of that powerful assortment of influences as temperatures, day length, or humidity and drought, which in vague combination we refer to as climate.

At the beginning of my grape breeding activities in 1935 a few fundamental theories and aims, relative to the climatic influence, were established which have been kept in mind all along the way. In fact they have constituted the foundation for the whole of my thinking and activity in this field. A simple outline of these foundation beliefs might be listed thus: (1) that the typically unsatisfactory results that have rewarded grape culture in most warm humid regions is due largely to inadequate winter chilling during the dormant period, as well as to conditions that greatly favor certain plant diseases, and to day lengths that are inadequate for the growth periods; (2) that all existent varieties of cultivated grapes are individually and as a group genetically unsuited to cultivation in any region with humid tropical or semi-tropical climate. The explanation in support of this is that, as a result of the temperate climate origin of all available vineyard varieties, such kinds have the inescapable requirement for cool or freezing winter (dormant) periods, and for relatively long days for the growth season, together with conditions of temperature and humidity that are not overly favorable for some plant diseases; (3) that the only real hope for a satisfactory viticulture in warm humid regions rests upon development of improved vineyard kinds from the primitive wild vines of the tropical forest. In a horticultural way almost nothing was known of these wild tropical grapes. Naturally, the course was to be slow and difficult.

It might be well at this point to emphasize the part that climate plays in success or failure with the grape. From the viewpoint of their climatic adaptability all grapes of the world,

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both wild and cultivated, fall naturally into three climatic classifications. These might be referred to as: (1) The arid-temperate, a group that includes the complex *vinifera* species that are popularly known in America as European or California grapes. This arid-temperature class is native to regions where minimum winter temperatures range mostly between freezing and 0°F., and where annual precipitation is from ten to twenty-five inches, mostly falling during the winter months. Where these conditions of temperature and rainfall prevail the European grape varieties usually are successful, whether it be California, Italy, Spain, North Africa or Argentina. But in those diverse regions where summer rainfall totals more than from forty to fifty inches or where winter temperatures frequently fall below zero, or on the other hand seldom reach freezing, the old world kinds show little promise; (2) The second climatic group might be referred to as the humid-temperate. Here we find the wild and cultivated grapes of eastern North America, north of Florida. Such well known varieties as Concord, Niagara, Delaware and the so-called Florida Beacon, rightfully belong in this group. For any of this class cool or cold dormant winter periods is a necessity, without which the plants at best will be short lived and doubtfully successful. (3) The third climatic classification, which we may call the humid-tropical, comprise the wild tropical grape species that are found naturally in the humid-tropical parts of South and Central America, the West Indies, Southern Mexico, southern Florida and the Philippine Islands. No improved or cultivated varieties of this tropical group are known, and consequently all ottempts at viticulture in the warm humid parts of the world have been compelled to rely upon varieties of the arid-temperate and the humid-temperate groups. The failure of these temperate climate plants under the alien conditions of the tropics could be expected.

If there is anyone who may yet entertain doubt as to the all powerful hand of climate that determines success or failure in viticulture, he would do well to make a careful appraisal of the plant life seen in tropical America. Almost without exception all of the woody perennial plants found prospering in the warm humid lowlands, be they ornamentals, fruits or forest trees, are of tropical climate origin. From my own observations I can scarcely cite a single instance where a temperate woody perennial plant has been seen growing successfully within the lowland sections of the torrid zone. Is this to mean that the better temperate climate plants have never been introduced nor adequately tested in the tropics? Most certainly not. The civilization of tropical America stems from Europe, and through the centuries temperate plants as apples, plums, cherries, grapes, and ornamental shrubs in great variety have been planted. Let us briefly appraise the results. In a few cases, such humid-temperate kinds as apples or plums may be found in the high mountains where low temperatures and even freezing winter weather is common. In the warmer lowlands these plants are never seen.

In connection with the grape the situation is a bit more difficult to understand though none the less definite in the end result. It is a fact of course that cultivated grapes are occasionally seen in various parts of the tropics. In a few favored spots, as in the Cauca valley of Columbia, even small industries have been built. I have viewed such plantings in the West Indies, and in Central America and South America, and have discussed cultural problems with the operators. The facts learned are that the vines generally are short lived, are lightly productive, and badly attacked by disease; only an extremely high price for the product has made the undertaking somewhat successful. In the majority of instances rare circumstances of climate or location, as the drying breezes along a seacoast, or semi-desert conditions of a local valley, have tended to substitute in some ways for the broader requirements of climate. But in a truly practical way, these rare mirages of success have led more to continuation of the quest in a hopeless direction, than to establishment of a healthy viticulture.

The foregoing reference has been of course to the well known cultivated grapes of temperate climate origin. With the tropical kinds the

condition is vastly different, as is shown when they are planted alongside varieties of the temperate groups.

Six years ago I planted in tropical Costa Rica healthy vines of the temperate cultivated classes as, Concord, Champion, Golden Muscat and others in locations adjacent to newly set plants of wild species native to southern Florida and Central America. After six years a striking comparison may be seen. The tropical species, including those native to the southern tip of Florida, together with many of their hybrid progeny, are large, healthy, and fruitful vines, while those native to more northern regions have remained stunted, are half dead and entirely worthless. No worthwhile fruit was ever produced by any of these temperate kinds. In fact only a very few even so much as reached the first trellis wire.

In addition to the strictly temperate sorts, we had in the same experimental vineyard vines of more southern kinds, plants that are native to the southern margin of the temperate region. These included the well known rootstock variety Dog Ridge of *Vitis Champini*, from south central Texas, together with many selections of the more southern *vinifera* imported from Persia and Morocco. It should be ample to say that none of these vines reached flowering size.

When grafts of the Texas Dog Ridge and the south Florida fox grape (*V. Shuttleworthii*) were placed on the same equally unrelated rootstock the south Texas variety remained weak and spindling, while the south Florida kind grew into immense size apparently equal in adaptability to the local *Vitis tiliaefolia* of the tropical forests. Only a few hundred miles north and south between their respective native habitats apparently determined the difference of success or failure in this tropical location.

Perhaps we would like to ask: where is this dividing line that marks the difference between temperate and tropical with the grape. Obviously, no truly exact line can be given. To help answer this, however, we might add that wild vines of several species collected in northern Florida showed definitely poorer adaptability, as expressed by delayed spring foliation and subsequently weaker growth, under the tropical conditions of Central America, than did those vines found native south of the Tampa-Melbourne region.

It might seem from the facts at hand that if we were to scribe such an artificial division line, it would more or less follow the isothermal lines that cross Florida a little north of Tampa. On the equatorial side of this divide, where frosty or freezing weather is not typical nor frequent, the wild grape species and the prevailing climatic influences might properly be termed tropical. On the temperate or northern side, where winter coolness is generally to be expected, the native plants and the growing conditions trend more toward the temperate classification.

From this it can be seen that the Orlando-Leesburg, Florida, section somewhat straddles the temperate-tropical divide. Though neither strictly tropical nor temperate it would seem to lean more toward the warmer than the cooler side.

In the foregoing it has been my intention to show that the temperate climate classes of grape varieties cannot be expected to give real and lasting success on the tropical side of the climatic divide and that in the more practical viewpoint central Florida might best be considered within the influence of the humid tropical classification. That would seem to leave us with but one alternative if a successful viticulture is to be attained in Florida: we must develop high quality vineyard sorts from the wild vines of tropical and subtropical forests.

What are the native grape resources of the warm-humid regions? Briefly, I believe it can be said that the humid-tropical group of wild species comprises perhaps even superior breeding material for horticultural development than did either of the temperate classes. The only difficulty is that we must go to the wild vines of the forest for our beginning.

Of the assortment of native wild grapes that may be found from central Florida south to the equator, three species groups have proven of outstanding horticultural value in the writer's experiments. These are (1) the leather leaf

grape, *Vitis shuttleworthii;* 2) a few subspecies of *Vitis aestivalis* as *V. gigas,* and the *V. rufotomentosa-V. smalliana* type which is of common occurrence in this part of Florida, often passing under the name of *V. simpsoni;* and 3) *Vitis tiliaefolia,* the common wild grape or 'Agras' of Central and South America and the West Indies. These three wild kinds embody most of the more important horticultural characteristics that in combination are required for the development of a fine new class of warm climate grape varieties.

The south Florida leather leaf grape has large fruit, is comparative early, has a thin skin and rather small seeds. A few of the better *aestivalis* subspecies have high sugar content, clear flavors, large clusters, and resistance to certain diseases. The Central American 'Agras' has extremely large clusters, in addition to resistance to still other diseases; in the writer's experiments this species has combined admirably with the other kinds.

The three warm climate species just discussed, when in hybrid combination with the better vineyard varieties of the arid-temperate and humid-temperate groups, gives an excellent foundation for further development of fine grape varieties for the warmer climates. This is supported by actual breeding results.

Notwithstanding the superb possibilities that await further development of the humid-tropical and subtropical class of grapes, it would be folly not to realize that such horticultural goals are never accomplished over night. It is a long uphill climb.

The early stages of a plant breeding program may ofttimes lead to a belief that nature may not look with favor on the first generation hybrid. Indeed, in the history of fruit improvement seldom have true hybrids between distinct species proven of worthwhile economic value. All too frequently the results of these first inter-specific crosses turn out disappointing, usually falling far short of the imagined goal.

In the writer's grape breeding experiments, selections were obtained that registered real and encouraging progress only after second generation crosses fruited. Then, the dominance of many unwanted characteristics, that typically so depressed the value of first generation progeny, was to a large extent avoided in these later combinations. This, of course is a phase of science well known to geneticists.

The overall breeding program was set up along lines of relative priority in regard to the more important and difficult foundation needs. The program was planned to follow in several stages of development.

First and foremost was the need for obtaining good adaptability to tropical conditions, combined with at least moderately good fruit qualities. This necessitated above all a scouring of the woodlands for the very best wild vines to be used as breeding parents. From 1935 to about 1943 this exploratory phase of the program was stressed. Many days of search in the swamps and along the streams of south Florida, the West Indies, and Central America netted a few wild grape selections of outstanding superiority. These were then crossed with the best cultivated grapes of the temperate class, and their progeny selections crossed back again on the better wild kinds.

During this first stage of the breeding program, stress was placed on obtaining as a foundation the more basic and difficult values that were found to be dependent upon complex multiple factor inheritance. This was felt to be of more importance as a basis for future improvement than was attention to values of the more simple type inheritance, as fruit colors, flavors or suitability for special uses.

Though we felt that attention to the more detailed simple-factor type inheritance did not logically belong in the first stage of this work, we tried to make sure that the needed genes were incorporated within the protoplasmic mass, to be brought into refinement at a later date. With due attention to the breeding and selection methods, there is little danger of losing these hidden and captive genes before they can be brought to desired perfection in the final breeding program. We have an illustration of this in the means, well known to plant breeders and geneticists, by which certain black fruited parent plants can

produce white or red fruited offspring as a recessive segregate. In the same manner smaller seeds, or even seedlessness, as well as larger berries or resistance to certain diseases and different flavors, can be given to a new hybrid selection by parents that have these qualities only in an unseen or recessive manner.

It is possible that the writer's angle of approach in this grape breeding program has differed somewhat from that more generally followed. In the earlier stages especially, major emphasis was placed upon mass rather than on detailed values. Effort was made to avoid concentrating attention on a few "pet" selections, or crosses or codes of procedure until their superiority was proven in adequate test. Whenever it has been possible to dispense with unnecessary detail, in favor of broader and more basic gains, that has been done. I believe this approach may well be justified by the unusually complex inheritance expression of the grape, together with the fact that we do not and, indeed, cannot during these more exploratory stages, know the full range of values or needs that exist within the plant. There is an apparent tendency, all too frequent with plant enthusiasts, to set up a scale of narrow values measurement, that may stem perhaps more from personal feeling or tenets of a pseudo science that would attempt to measure life with a yardstick, than from objective and thorough understanding of a most intricate organism. To follow such a course may well lead to a dead-end way from which the only escpae may be disappointment and years of lost effort. Broadness of foundation is the only safeguard we have in this direction.

Although it has been the aim of this paper to discuss the viewpoints, the methods and goals behind fourteen years breeding work with the warm climate grapes, there may be those impatiently realistic persons who would like to know something of actual accomplishments to date. What tangible goals have been reached that can support the logic of our course?

To this it can be said conservatively that we have developed, and now have under field test, varieties with proved adaptibility to warm climate conditions comparable to that of the tropical wild species, combined with fruit quality the equal and in some respects the superior of such old varieties as Concord or Beacon. Within the 'bloodstream' of this new humid-tropical class of vineyard grapes we have obtained cluster and berry size and fruit flavors that are comparable to the better Old World sorts. The well known *labrusca* flavors of the North American varieties have been brought out in good blending with the better attributes of the tropical wild types. It is true that as yet no one selection has combined all of these desired merits in a single ideal variety. The fact is that we have not yet aimed at this final goal. However, a conservative view of known grape genetics shows clearly the far reaching possibilities that can be expected when with large progeny populations in the final refinement phases, we set about to combine these established attributes within a few perfected varieties.

The tropical class of vineyard grapes is already an actuality and ultimate goals are within sight. Our next question might well be: where do we go from here? What is the future of commercial viticulture within the warm-humid regions of the world? Broadly speaking, it might be said that it is most extensive.

Here, of course, it should be fully understood that we have made reference to a new climatic class of horticultural grape varieties when placed against its optimum background within the broader climatic interpretation. Just what may be the possibilities within any specific locality will hinge of course upon many local conditions.

What will these grapes mean to north central Florida? My brief familiarity with this section will not permit an answer to this question. Only actual and adequate trial can determine this. New methods and new procedures will have to be developed. Past failures or limitations of the vastly different varieties formerly planted afford no real clue to future possibilities with the new kinds. However, consideration of the high prices and even

partial success sometimes obtained allow something of a hint of what might be possible with vastly superior kinds.

From the plant breeding standpoint, there seems to be little reason to doubt that with due scientific attention and a few years time the market quality of the new humid-tropical class of grape varieties might be improved sufficiently so as to compete favorably on the market with varieties grown in California. On such a basis Florida could be in a very favored position. It is now only speculation but it is something worth considering.

VEGETABLE SECTION

PRACTICAL ASPECTS OF NEMATODE CONTROL WITH CHEMICALS

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Few lines of agricultural research have greater potential possibilities than control of soil inhabiting organisms that injure the root of plants. Few problems are more difficult and results more uncertain. The need of effective measures for controlling root diseases has been demonstrated by the rapidity with which the practice of soil fumigation has come into use during the past few years. Some of the first tests to determine the nematocidal properties of ethylene dibromide were made during the latter part of 1944. Today four different companies are marketing ethylene dibromide fumigants and many thousands of acres are treated with these materials each year. During the same period the use of dichloropropene fumigants has increased with equal rapidity.

From time to time one hears of suggestions regarding the qualities that a chemical should possess to make it an ideal soil fumigant. Among these qualities is the ability to kill a wide variety of different soil organisms, including those that belong to the animal kingdom, such as insects and nematodes, and those that belong to the plant kingdom, such as fungi and weed seed.

Along with a good many others, I have spent considerable time searching for a fumigant that combined nematocidal and fungicidal properties to a high degree. Useful as such a material certainly would be, fungicidal properties in a fumigant are not an unmixed blessing. There have been instances where fumigants possessing this quality, but applied primarily for controlling root knot, have resulted in better plant growth than was obtained from fumigants lacking it or possessing it to a lesser degree. Very frequently, however, fungicidal properties in the fumigant have not given any improvement in growth and in such cases they may be a disadvantage.

Generally speaking, a chemical that is effective in killing fungi is much more likely to be injurious to the roots of plants than a chemical that is effective in killing nematodes and insects. An inherent disadvantage of all fungicidal fumigants is the necessity of getting the gas almost completely out of the soil and the more fungicidal the material the more careful one must be in this respect.

Are volatile liquids the only chemicals that can be used for controlling root diseases on a field scale? One frequently hears it suggested that the ideal material for controlling root knot would be a solid that could be applied like a fertilizer, probably mixed with fertilizer. When we examine this suggestion critically the first thing we realize is, that to be effective in controlling nematodes, any such non-volatile

material would need to be mixed with the soil much more thoroughly than fertilizer is mixed ordinarily. However, the application of volatile liquids has not proven to be easy or inexpensive and with modern tilling machinery the mixing of a solid might not be any more difficult. The application of the chemical to a strip 14 or 16 inches wide along the planting row is just as logical as row fumigation.

That a material may be found which can be applied in sufficient quantity to kill nematodes, and probably insects, without seriously injuring the roots of plants seems at least a possibility. That such a material will also control fungi seems unlikely. If such a material were applied to a strip along the planting row, and if it retained its nematocidal properties for a month or so after being mixed with the soil, it might have certain advantages over a soil fumigant.

a. Requirements regarding the physical character of the soil might be less exacting, e. g., a fairly high moisture content, important if fumigants are to be fully effective, might not be necessary.

b. The roots of the plants might be protected for a longer time against nematodes that migrate in from adjacent untreated soil. When dependent on its own powers of locomotion, the root-knot nematodes spread very slowly. Some of the other nematodes that injure the roots of crops move through the soil more freely.

c. Such a nematocide might be effective in reducing reinfestation from infected planting stock. Taking gladiolus as an example, the only way by which a root-knot infection can spread from the old corm to the new growth is by eggs hatching and larvae escaping into the soil. If the surrounding soil contained an active nematocide the plant might be protected, not only from the nematodes that occur in the field, but also from those that escape from the old corm.

Although, to some extent, these are theoretical considerations, they are suggested as reasons why the search for nematocidal materials should be continued and why we need not necessarily restrict ourselves to testing volatile liquids.

GROWING STAKED TOMATOES ON THE WEST COAST OF FLORIDA

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Ruskin

Probably the most distinguishing thing about west coast tomatoes is the fact that they are staked. This then brings up a question of why we stake our tomatoes. To properly give a clear picture of the subject, I think it advisable to start in at the first of a season and carry on through to its end in the various stages. I will try to answer the question WHY as we go along, and also give you some idea as to what we have learned through our various observations and experiences.

First let us divide the subject into these five parts: (1) Planting, (2) Fertilizing, (3) Spraying, (4) Staking, Pruning and Tying, (5) Yields.

PLANTING

Staked tomatoes on our farms are planted eighteen inches apart on four and one-half foot beds. This then means that with staked tomatoes we have more plants to the acre and hence a larger yield. In figuring the amount of plants per acre our figures run between 6900 on ground using seepage irrigation with eight rows to the land. I might explain that we refer to a land as being eight rows with an irrigation ditch on each side, actually you lose two rows out of ten for irrigation ditches using this method. On ground using sub-tile irrigation we have close to 7300 plants to the acre.

For the past three seasons land was alloted to the Vegetable Crops Lab. of Braden-

ton for use in a variety test. In the fall of last year a total of 18 varieties were planted and last spring a total of 12 varieties were planted. I will not discuss all the varieties, but will discuss those which proved best as far as commercial growing is concerned.

During the Spring crop of this year, we had a total planted acreage of 39 acres, this was broken down as follows: 26 acres, Stokesdale; 10 acres, Southland; 3 acres, Test ground for our farm, and the Veg. Crops Lab., Bradenton.

In the above acreage the results were that the 26 acres of Stokesdale produced a fair amount of fruit, predominately small but of good quality. The Stokesdale has always been respected for its quality in this area, but has what you might say lost face with many of the growers at this time. Stokesdale was extremely susceptible to Fusarium wilt and practically any other disease. The 26 acres in question as far as quality went produced good smooth fruit and a fairly heavy yield, but during the mid-season Fusarium wilt spread over the complete field and almost resulted in a total loss. It is the general consenus of opinion that the strain is going out and for this reason we have decided to stop using Stokesdale until it is improved.

The 10 acres of Southland was truly a beautiful patch of tomatoes. Naturally it had its drawbacks. The Southland was a heavy foliaged plant which was resistant to Stemphylium, Alternaria, Collar Rot and Fusarium Wilt. The yield was heavy and the fruit was large, but overall was quite rough. Probably one reason that the fruit appeared rough was the fact that it was creased quite deeply its size undoubtedly fooled pickers and was picked too young. Some that were allowed to stand for a few days smoothed out considerably on the first two fruit hands, but the main drawback was the large blossom end scars which were predominate. The over all average was less than 10% number one tomatoes, and less than 20% ones and twos. After the first two fruit hands the fruit became extremely rough more so than that just mentioned. The Southland is perhaps one of the meatiest and the most tasty tomatoes on the market today. In ripening tests including these varieties I found that the Southland held up better for its market than any of the others with the exception of one which is the Manahill to be discussed in a minute. We decided not to use Southland again except for small test rows, because of its extreme roughness after the first two fruit hands. This variety undoubtedly needs more work especially for this area.

The three acres of Test land was used for tomatoes which we were testing and also for the Experiment station. Our test block had Lakeland, Manahill, and Manasota planted. The experiment station had 12 varieties planted this past spring, the main ones being Lakeland, Manahill, Manasota, Rutgers and Jefferson. The results were quite interesting and resulted in our picking varieties for probable commercial growing as far as our own farm went. The Lakeland proved to be a Stokesdale type as far as quality and resemblance went and contrary to advertisements and claims, it was very susceptible to blossom-end rot, and Fusarium wilt. Naturally we decided not to use this variety in the future. The Manahill and Manasota however proved so good that we saved seed from these varieties in order to plant 17 acres of the oldest ground we have, for the present crop. Nature however took a hand, what with the hurricane and shortly thereafter we had a solid week of rain, it destroyed most of the plants with the ultimate result that we now have 39 600-foot rows of Manahill and Manasota mixed. This is more or less just to see how they will do this fall. Strangely enough the results of the Manahill and Manasota tests on our ground were just the reverse of what they found in Bradenton. Our Manahill produced the best between the two varieties, larger fruit and a bigger yield. This variety turned quite rough on fruit hands above the third. This was for some reason characteristic of almost all varieties last spring. The Manasota turned out quite well and was a fairly heavy bearing variety, the fruit being a little smaller but earlier than the Manahill. For that reason Manahill is not recommended

for fall planting whereas the Manasota is. In the test block of the Bradenton experiment station on our land they found practically the same findings with regard to the Manahill and Manasota, but as stated before at Bradenton in their test block, they found just the reverse. Their other varieties tested were Rutgers and Jefferson, plus others which I will not mention. Rutgers and Jefferson proved very good, the Jefferson being superior. The Jefferson is a heavy bearing, wilt resistant plant and produces good large fruit. The recommendations are therefore that either Jefferson or Manahill be planted in the spring, and that Manasota or Grothens be planted in the fall. Our first choice for next spring is the Manahill and second is Jefferson. This fall we have all Grothens planted plus the test block by the Experiment Station and also the 39 trial rows as previously mentioned. Our Grothens are several brands, we have them by Kille, Ferry Morse and Woodruff. Just which brand is best is hard to say but they are the most popular brands in our section. Grothens have proven to be a good fall tomato and for that reason we have used Grothens in the fall. They are quite susceptible to Fusarium Wilt and we are experiencing some difficulty with that disease at this time both in new ground and in old.

Fertilizing

The soil in our section is the flat sandy pine land type and has very little plant food in it to begin with and for this reason unless a good fertilization program is followed production would be nil. Before bedding up for the crop Dolomite is broadcast over the ground at the rate of two ton per acre on new ground and one ton per acre on old ground. The amount of Dolomite used is not figured in the fertilizer program. At the present time we plan on using a total of approximately 2500 pounds per acre for a season. This used to run in the neighborhood of 3000 pounds to the acre, however after tests were made of the soil after the last season it was found that there was a large amount of available nitrogen left in the ground which had not been used, in some cases as much as 160 pounds to the acre. With these findings it was the recommendation of the experiment station that the amount of fertilizer used be reduced.

The most important factor in our fertilizer program is the weather. Good weather will mean that you can follow your program pretty closely, whereas wet weather will necessitate more fertilizer. Our soil being so sandy allows the rain to wash away a large portion of the fertilizer and would leave the plants deficient in plant food unless more were added. As I said before our present program calls for approximately 2500 lbs. per acre total. This is broken down in this manner:

In setting out we bed with 4-8-6 60% organic at the rate of approximately 700 lbs. to the acre.

We side dress two times the first of which we use 4-8-8 50% organic with secondaries applied at the rate of 700 lbs. per acre, the second side dressing is applied with 4-8-8 40% organic with secondaries at the rate of 700 lbs. per acre.

All the fertilizing up to this point is done with tractors, but when top dressing is applied, the stakes are in. This therefore requires either an overhead cultivation rig or the old fertilizer distributor. In applying top dressing we use 4-8-8 80% organic with secondaries and use approximately 400 lbs. to the acre.

Seed beds require high chemical composition for quick action, so for this we use 12-10-0 in all seed bed fertilizing.

Spraying

Spraying is accomplished with overhead spray rigs such as that pictured in the cards which I had passed around, we spray every five days from the time the plants are an inch high until the last picking made. Many diseases and various types of worms thrive in this climate and seem to prey on tender plants such as tomatoes.

One of the most effective Insecticides that we have found is Parathion, a good example of this is our crop last fall. Leaf minors were causing considerable damage and DDT 25% was not touching them. Chlorinated Camphene was recommended and tried, the kill was about

40 to 50% and shortly thereafter they tried to take over again. Parathion was then recommended and tried. The first application was nearly a 100% kill and after the second application there were no live leaf minors found. We have also found that Parathion is extremely successful in control of the Green Tomato Horn Worm. It has been our practice to combine a fungicide with an insecticide. The most commonly used fungicide is Copper A.

During damp and rainy weather we experience considerable trouble with rust and blight. To arrest these we use Diathane. It is very effective in controlling these types of diseases.

By rotating the spray program we have had better overall results. By that I mean rotating the material used, i. e., Copper A and Parathion one time, and Copper A and DDT 25% the next, or Diathane and Parathion, etc.

Along the insect line our trouble is with mole crickets and cut worms at the beginning of a season. We have found very effective control by broadcasting Bran-Chloradane through the middles. If the ground is damp or if we are lucky enough to have a light shower immediately after application, it is much more effective.

Staked tomatoes are more easily sprayed than ground tomatoes and disease and insect control is more easily accomplished by having the tomatoes staked. The plants are above the ground and allows the spray to penetrate thoroughly, whereas with ground tomatoes, it would take longer for the spray to penetrate to accomplish the same job.

Staking, Pruning and Tying

I have combined staking, pruning and tying under one heading as they are three operations which takes little time to tell about and also are three operations which are characteristic of staked tomatoes.

On our farm our tomatoes are pruned to a single stem, then tied to the stakes which have been set in the field immediately after the second side dressing. Two to three ties are put on each plant, spaced approximately ten days apart. The number of ties is dependent entirely on the speed of growth and height attained. The pruning continues until the plant has 5 to 6 fruit hands on it then the bud is taken out, an operation we call Topping. These operations are really the costly part of the crop. It is all hand work and must be done with considerable care. Staking is done by a crew of 19 taking one land of eight rows at a time. Pruning is done mostly by the women and tying is done by both men and women and is done by contract at so much a row.

Yields

By staking and pruning our tomatoes we figure that it makes our crop about two weeks earlier which is an asset in itself. Plus the fact that our yield will be free of tomatoes rotted from touching the ground. In our section as in other sections of Florida due to an organism or bacteria in the soil tomatoes that touch the ground will rot at the point of contact. This is more prevalent in wet weather. The staked tomatoes naturally have the fruit up away from the ground thus preventing the rot from occurring. Therefore by having less loss due to ground rot the yield is further increased. An average yield for our section is 225 orange crate field boxes per acre, with an average pack out of from 2.20 to 2.25 lugs per field box. In comparison, the last ground tomatoes raised in this section produced only 70 to 80 field boxes per acre. We can therefore say that staked tomatoes in this section DO produce a larger yield.

Now in short summary I would say that from the variety tests we found the best spring tomato to be either the Manahill or Jefferson, the best fall tomato either Manasota or Grothens. That fertilizing with a mixture of 4-8-8 60% to 30% organic with secondaries at the rate of approximately 2500 lbs. to the acre total is best on our farm. We have found best disease and insect control by using Parathion, DDT 25%, Copper A and Diathane. And last that we find worms, insects and diseases easier to control with staked tomatoes. That our yields are at least two weeks earlier

and gives us a much larger yield than with ground tomatoes.

In closing I would like to say that through cooperation of Mr. Keibert and Dr. Walters of the Bradenton Experiment Station, we have learned a lot about the various varieties, and also have learned a lot more of the whys and wherefores of farming in Florida. The experiment stations can really help you if you will let them.

IN-THE-ROW APPLICATION OF SOIL FUMIGANTS FOR VEGETABLES ON SANDY SOILS

J. M. Walter and E. G. Kelsheimer

Florida Agricultural Experiment Stations
Vegetable Crops Laboratory

Bradenton

Soil fumigation is a currently very popular subject with the vegetable growers of Florida. This is, we believe, as it should be, because our tests conducted during the past four crop seasons have shown that from our land we can expect very attractive returns for the use of the nematocides D-D or ethhylene dibromide (diluted with mineral spirits and sold under different trade names).

However, our laboratory is not yet making any definite recommendations on soil fumigation with these new chemicals because we are well aware that our information on the subject is dangerously little. To illustrate how little we know about some important facets of soil fumigation, we can report that three weeks ago a regional representative of one of the big chemical companies that has been selling fumigation service in the state for the past three years stopped at the laboratory and advised us that results obtained by the company's scientists during 1949 show that water solution is the effective phase of their "fumigant." All of us had, of course, labored from the outset with the mistaken idea that the chemical produced its desirable effects while in a gaseous stage, and that, for this reason, it was proper procedure to apply it to well worked, well aerated soil and then seal the surface of the treated area by sprinkling if a quarter-inch of rain were not expected within a few hours.

Another facet of the subject that makes it appear unwise for the experiment station to issue hurried recommendations for use of fumigants is the hazard, slight though it may be, that under some unusual conditions a fumigant may result in a vegetable crop being tainted, a bit off flavor, or reduced in quality.

In-the-row application of soil fumigants has been given special attention in our tests, which were begun with the fall crop of 1947. The reasoning leading to the decision to specialize upon in-the-row application included the following considerations:

1. The available technical information and the long-time experience of growers concerning the effects of root-knot on vegetable crops appeared strongly indicative that a major share of the reduction in yields usually arises from the effects of the nematodes on seedlings or transplants during the first four or five weeks of their time in the field. In general, the radius of root spread from vegetable crop plants during the first four or five weeks would not exceed the radius of effectiveness demonstrated for 'spot' applications of the soil fumigants.

2. Many interested growers objected to the cost of the full-scale application offered as custom service by the chemical companies at rates ranging from $35 to $60 per acre. In-the-row application allows a reduction in the amount of chemical needed per acre to from 1/6 to 1/2, depending upon the between-the-row spacing of the crop under consideration.

3. It appeared reasonable that any possible accumulation of harmful chemical residues or development of unfavorable physical conditions of the soil, points on which there is, as yet, no definite information, would be minimized by limiting the amount of chemical applied per acre to the fractional quantity

called for by in-the-row application.

4. Preliminary observations suggested that use of the soil fumigant every time a given piece of land is prepared for a crop would have advantage over periodic full-scale application. In some cases root-knot was found to be very severe on the second crops grown six to nine months after full-scale treatment. Though the first crop following the treatment had been excellent, it appeared in some full-scale treated areas that the second crop suffered more severe damage than normal for similar non-fumigated areas.

The first experimental trial of in-the-row application of soil fumigant at the Vegetable Crops Laboratory was made on staked tomatoes in rows four feet apart. The materials tested were Larvacide, D-D, and Soil-fume 80-20, (ethylene dibromide 20%-mineral spirits 80%) the quantities applied on a per acre basis being one fourth the normal full-scale dosages of approximately 500 pounds, 200 pounds and 26 gallons, respectively. Applications were made with Mack guns after the beds had been prepared in the usual fashion, and the use of cultivators that could throw non-treated soil from the middles to the beds was delayed as long as possible. The plot design meant 64 replications of 10-plant plots in a test involving fungicides and insecticides as well as soil fumigants. The trial was made on land that had been used for tomatoes regularly for several years, and root-knot was known to have been almost 100 percent prevalent on the plants of the preceding crop.

The results of this first trial appeared very encouraging, Larvacide, D-D, and Soil-fume 80-20 giving increases of approximately 50, 25, and 15 bushels of marketable fruits per acre, respectively. However, the season was unusually wet, and root-knot was so slight that we do not believe it could have been a factor contributing to the yield differences noted. At the end of the harvest season five plants of each plot were lifted and rated for root-knot severity. Analysis of the numerical data showed that root-knot was more severe on plants of the non-treated check plots than on those of treated plots, there being no differences between the three chemicals in this respect.

The second experimental trial involved the same three soil fumigants but included a comparison of the dosage used in the first trial with half and double that amount. The test was made on the same field as the first, and root-knot was known to have been uniformly very severe on an intervening crop of tomatoes and peppers.

This test involved tomatoes of the fall crop of 1948. The field was prepared and bedded on Aug. 20 and the fumigants were applied at four to six inches depth with Mack guns on Aug. 21. A light rain fell on the night of Aug. 21-22, and enough rain fell during the ensuing week to keep the soil damp. On Aug. 30 the beds were stirred to a depth of five inches with potato forks to allow drying and aeration of the soil. The beds were again stirred on Sept. 1 and tomato plants of a wilt resistant stock were set later in the day. On Sept. 3 it was found that the plants on plots treated with Larvacide were nearly all dying because of chemical damage. All plants involved in the experiment were then eliminated by a deep hoeing that further aerated the beds. The soil was again stirred to five inch depth with potato forks on Sept. 6. All of this hand tillage of the soil to promote aeration and dissipation of the chemicals was accomplished without destroying the original beds. The second and final setting of tomato plants was made on Sept. 8, i. e., 18 days after application of the fumigants. By Sept. 11 it was obvious that the normal and double dosages of Larvacide were still damaging some plants. However, since it was considered important to have the crop in season with the commercial production of the area, it was decided to proceed with this stand and do no fill-in resetting.

No cultivation that could throw non-treated soil from the middles to the treated beds was done until Sept. 20, and then it was held to a minimum. Otherwise the crop was given standard treatment for staked tomatoes of the area, the fertilization, cultivation, and spraying for control of diseases and insects being as recommended by the laboratory.

The results of this test of soil fumigants are summarized in Table 1. The yield data are totals of seven consecutive weekly pickings, and are not corrected for stand or plant count. The poor yields from the normal and double doses of Larvacide are without question a reflection of the stand reduction caused by the chemical. This is pointed out merely in fairness to a highly effective soil fumigant. However, Larvacide was included in the test only to serve as a check, there being no prospect that it could be recommended for general usage by growers because it is too dangerous and disagreeable to be handled by any except cautious and skilled workmen.

D-D and Soil-fume 80-20 caused no reduction in stand. However, it was noted that the plants on a plot treated with Soil-fume and located at the lower end of the field grew to eight or ten inches height and then made no progress for two weeks while plants on nearby plots treated with D-D and Larvacide were making good growth. The plants on this retarded plot made strong recovery after the delay of two weeks and eventually produced a good yield of high quality fruits. An observant grower of the district reported a similar retardation for the same period on wet land treated with Soil-fume, his field affording the comparison between D-D and Soil-fume. This retardation of growth where the soil holds excessive moisture after treatment with Soil-fume nicely exemplifies the type of important factor or relationship on which our information is insufficient to warrant recommendations to growers. It appears certain that soil type and seasonal rainfall are important variables that will require considerable study before general recommendations can be made. The soil type on which the tests here reported were conducted is Manatee fine sandy loam, heavy phase.

TABLE 1.
EFFECTS OF DIFFERENT DOSAGES OF SOIL FUMIGANTS APPLIED IN THE ROW OR BED ON YIELD AND SEVERITY OF ROOT-KNOT OF TOMATOES

Fumigant	Amt. per A.	Bu. Marketable Tomatoes per Acre	Average Root-Knot Severity Ratings*
Larvacide	250 lbs.	282	6.3
	125 lbs.	300	5.3
	62.5 lbs.	350	4.6
	Average	311	5.4
D-D	100 lbs.	339	6.6
	50 lbs.	365	6.0
	25 lbs.	329	5.2
	Average	344	5.9
Soil-fume 80-20	13 gals.	348	6.2
	6.5 gals.	373	6.2
	3.25 gals.	319	4 4
	Average	347	5.6
Non-Treated Controls	0	246	3.0
	0	245	3.0
	0	254	2.9
	Average	248	2.9

*Evolved from an inverse scale ranging from 0 to 10. The higher the rating the less severe was the root-knot.

The root-knot severity ratings shown in Table 1 were taken by digging and examining the roots of all plants in the test. This could not be done until Dec. 31, 1948, after the final weekly harvest, of course. The numerical scale used for the ratings were devised for comparison of tomato breeding lines under test for resistance to root-knot. For this reason, the lower the rating the more severe was the root-knot. The scale is as follows:

0=Severe root-knot with galls mostly ruptured.

2=Moderately severe root-knot with approximately half of galls ruptured.

4=Moderate root-knot with few galls ruptured.

6=Slight root-knot with some galls size of pea but none ruptured.

8=Very little root-knot; galls few and small.

10=No root-knot.

As suggested by the data presented, none of the treatments prevented root-knot and practically one hundred percent of the plants showed more or less galling. However, there is good reason to believe that yield is not reduced by root-knot of the classes represented by numerals six and eight, provided the plant had opportunity to become well established before the infections occurred. In other words, it appears that a root-knot severity rating of 6 or higher, referring to the scale and table above, can be taken to mean that yield probably was not influenced by root-knot. It

seems reasonable to assume, of course, that galls represented by six and eight ratings were caused by late-season infections.

The point of prime concern to growers indicated by the yield data shown in Table 1 is that a double dose of the fumigant shows no advantage over the normal or regular dose. This information may enable many growers to reduce their production costs and still reap maximum benefits from the use of soil fumigants. Biometrical analysis of the plot yields on which the summation presented in tabular form is based shows that yield did not vary with dosage, but shows clearly that all three doses of all three chemicals gave great advantage over no treatment. Biometrical analysis further indicated that doubling the dose of fumigant gave no reduction in severity of root-knot over the normal dose, but that cutting the dose to half-rate allowed significantly more severe root-knot without significantly reducing yield.

A third test furnishing tomato yield data on the influence of soil fumigation with ethylene dibromide was carried out in the spring of 1949. This test was made on a field that had been treated full scale with D-D on Aug. 15, 1947. The tomato crop put on it for the fall crop of 1948 had been ruined by root-knot. Hot, dry weather conditions prevailed during almost the entire spring crop season. It is considered, because of the circumstances mentioned in the preceding two statements, that this was a most severe test of soil fumigation for nematode control. The prime objective was to compare in-the-row application with conditions.

The results in terms of marketable (U. S. No. 1 and No. 2) tomatoes show no significant differences between in-the-row fumigation and full-scale fumigation, but they show that Soil-fume 80-20 applied either way roughly doubled the harvest, the average yields being 105.2 bushels per A. for plots not fumigated and 216.2 bushels per A. for plots fumigated in-the-row. The yield from plots treated full-scale was 184 bushels per A., this figure not differing significantly from the 216.2 for in-the-row treatment.

In terms of root-knot control ratings, the results of the spring 1949 test show in-the-row application superior to full scale application, which is in turn superior to mineral spirits (diluent used in reducing concentration of Soil-fume 60-40) and to no treatment in controlling root-knot. There was no suggestion that the best treatment could prevent the development of root-knot under such conditions.

It appears desirable to mention that the writers have not yet observed a case of soil fumigation on a field scale, regardless of method of application, in which the treatment prevented the development of root-knot on a susceptible crop that remained in the field for as long as three months. There seems to be no doubt that the longer the term of the crop the greater the need for perfection in the control of nematodes. Further, it appears only reasonable that the grower must take every possible precaution that will help in attainment of perfect control of root-knot in seed-beds. There is not much point in fumigating a field for control of root-knot if the plants to be set in it are already infested.

The tedious hand procedures necessary for our early studies on in-the-row application of soil fumigants prompted the junior author to design a simple, inexpensive, effective, home-made attachment for the bedding-cultivating tractor that has proven a very useful in-the-row applicator on the experimental farm and is being used as a model by many farmers and some supply agencies of the district. In our use of the rig the application of fumigant, appication of original charge of fertilizer, bedding and boarding-off are all done in the one operation. The fumigating attachment, or one just as satisfactory for the purpose could be made by any handy-man farmer for very little expenditure of time; and the cost of the materials need not exceed $5.00. The essential features of the attachment are as follows:

(1) A 10 gallon steel drum (an old chemical container) mounted on the front axle of the tractor, the drum having, near the bottom, a galvanized pipe outlet soldered to it;

(2) A 5/16″ diameter copper tube ex-

tending from the outlet in the drum to proper position to place the trickle of fumigant in a line representing the approximate center of the bed formed by the discs;

(3) A shut-off valve near the base of the drum and controllable from the driver's seat; and

(4) A regulator valve in the line of copper tubing.

The regulator valve is set for the desired gallonage per acre by trial and error, as follows:

(1) The tractor-driver determines the position of all controls when tractor is moving at normal, steady pace in the preparation of beds;

(2) By taking the average of several readings, the number of seconds required for the tractor to move 100 feet at the steady working pace is determined;

(3) By calculation it is determined how many cubic centimeters of the liquid to be used are required to treat 100 feet of row at the desired dosage;

(4) The regulator valve is changed until it allows the proper volume of the fumigant to flow into a graduated container in the number of seconds required for the tractor to move 100 feet. The tractor is standing still for this calibration, of course.

The above-described apparatus allows the adjustment and control of application rate per acre with satisfactory accuracy under our conditions, which include a first-class tractor driver.

As delineated in preceding paragraphs, our experience to date clearly indicates that the proper dose for maximum net gain is 2.5 cc. of Soil-fume 80-20 per foot of row. For D-D the rate is the same. For Dowfume W-40 or Soil-fume 60-40 this becomes 1.25 cc. In terms of full strength ethylene dibromide, this means 0.5 cc. per foot.

Since our rig is dependent upon gravity for the flow of the liquid we believe there is definite advantage, for the sake of uniformity, in arranging for a relatively strong flow instead of a mere trickle. In general practice we now use one measure of Dowfume W-40 or Soil-fume 60-40 diluted with two measures of mineral spirits, and apply approximately 3.75 cc. of this mixture per foot. This means, that, with rows four feet apart, about 10 gallons of the mixture are required to treat an acre.

The cost, at current prices, for materials to treat an acre as described in the preceding paragraph is roughly $9.00. Since our results show a net return of approximately 100 bushels of marketable green-wrap tomatoes for this expenditure, it appears that the grower operating on old sand lands can well afford to take the trouble to fumigate. The writers have used this fumigation procedure in recent crop seasons for peppers, pole beans, and cucumbers with good results but have collected no data on the yield responses shown by these crops.

In the face of the enticing possibilities for the vegetable grower to gain by chemical soil fumigation, as suggested by the foregoing, the writers feel it necessary to reiterate their introductory remark that we still know dangerously little about the subject. Let us, in closing, enumerate some questions on which we do not have enough information.

1. Can soil fumigant be used repeatedly on a valuable tract of land without lasting damage of some type?

2. Will the responses observed on Manatee fine sandy loam (heavy phase) be representative of responses from other soil types used for vegetable production in Florida?

3. Will a fumigant always be harmless in-so-far as quality of all vegetable crops is concerned?

4. How long after fumigation must the grower wait before each crop can be seeded or set? Conceding that soil moisture is an important factor in this connection, how can the grower determine when it is safe to start the crop?

5. Is it advantageous to seal the soil surface after treatment if the chemical is applied while the soil is damp?

6. What is the proper usage of fertilizer in relation to soil fumigant?

The Agricultural Experiment Stations are striving to determine the answers to these questions as soon as possible.

THE PRESENT STATUS OF SPRAYS AND DUSTS FOR THE CONTROL OF INSECTS ATTACKING THE EARS OF SWEET CORN

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Belle Glade

Sweet corn production has attained major importance in Florida in recent years, and promises to remain a permanent part of our agriculture providing we are able to place on the market a good quality product. The demand for superior quality sweet corn has been vividly demonstrated through the markets during the past season when fancy and U. S. No. 1 grades brought premium prices over the lower grades. The growers are naturally quite anxious to produce sweet corn which will fall into the top grades and bring premium prices.

Insects constitute one of the most severe difficulties in this effort to obtain high quality corn. Throughout the State the fall armyworm, *Laphygma frugi-perda* (A. & S.) and the corn earworm, *Heliothis armigera* (Hbn.) attack the ears of sweet corn. In South Florida the corn-silk fly, *Euxesta stigmatias* Loew, is a third major pest. Each of the above species is capable of destroying the market value of sweet corn. The fall armyworm and the corn earworm feed as budworms in young corn and, if present when the tassels form, they migrate from the tassels and eat into the developing ears. The corn earworm moth and the corn-silk fly adult deposit most of their eggs on or near the silks and the young larvae tunnel into the tips of the ears.

It appears that many vegetable producers will plant sweet corn next spring for the first time, and some of those who have previously produced this crop will purchase or build special spray and dust equipment for insect control. Many persons who are interested in sweet corn production are confused as a result of conflicting reports relating to the control of insects attacking this crop. They have heard of growers who have obtained 90 to 100 per cent worm free ears as a result of a rigid dust or spray program. On the other hand, they have reports from other growers who have obtained very poor control even under a 48 hour dusting program throughout the silking period.

At the Everglades Experiment Station the sweet corn insect problems have been followed rather closely during the past year in a series of replicated experiments, field trials and frequent visits to commercial plantings. It is the purpose of this paper to summarize these studies. Since considerable data have been accumulated, no attempt is made to include details in this report, but rather to discuss the results of the more pertinent phases of the work.

SEASONAL FLUCTUATIONS IN INSECT PREVALENCE

Observations during the past few years in the Everglades Area indicate that while the major corn insects may occur at any time throughout the year, there are definite fluctuations in populations of these insects which seem to fall into a seasonal pattern. Sweet corn planted in the fall of 1948 and silking in November was observed to be heavily infested with fall armyworms and corn-silg flies, but corn earworms were not present. Examinations of commercial sweet corn plantings silking in February and March, 1949 revealed a very light infestation of corn earworm eggs deposited on the silks, and corn harvested from these plantings was over 90 percent free of worm damage. In one of these commercial plantings where experimental plots were established, the untreated plots averaged 96 percent worm free ears. A small planting of sweet corn at the Experiment Station, silking the last of March contained 29 percent worm free ears in the untreated check plots,

while another planting silking the latter part of April was 100 percent infested with earworms. It became evident during April that the corn earworm infestation was becoming more severe in the Everglades. Corn silking in May and early June was generally severely infested and the intensive insecticide programs failed to produce a high percentage of worm free ears. The last commercial planting examined produced silks during the latter part of May. This crop was airplane dusted every 2 days with 6 percent DDT at the rate of 30 to 35 pounds per acre. Numerous earworm eggs were found on the silks and at harvest time 75 percent of the ears were damaged by corn earworms.

A Summary of Research Investigations —1948-1949

A report of experiments conducted in the Spring of 1948 was presented at the 1948 Annual meeting of the Florida State Horticultural Society in West Palm Beach. This report included data showing the superiority of an atomized oil based DDT spray over the dust formulations in controlling the corn earworm. The oil treatment interfered with pollination, resulting in many ears with one to three inches of the tips not filled out. A series of trials have followed this work in order to determine whether or not a method could be developed which would maintain the high degree of control with a minimum of tip damage due to the oil treatments. Preliminary work with oil emulsions and with atomized spray applicators has been completed and several dust formulations have been tested for their effect upon adult corn-silk flies and corn earworm moths. The more important information obtained from these studies follows:

1—A solution containing 2 percent DDT in mineral oil atomized by hand upon freshly wilted corn silks at the rate of 1.2 cc per ear gave excellent control of the corn earworm with a single treatment with only slight damage to tip development, providing the treatment was properly timed. Silks treated before pollination had taken place gave excellent control but caused excessive tip damage, and silks treated after they had begun to turn brown caused no tip damage but showed only fair control of earworms. Mineral oil—pyrethrum injection was superior to atomized sprays where the silks had begun to turn brown.

2—The DDT-mineral oil atomized spray treatment was highly effective against the fall armyworm and the corn-silk fly when three treatments were made during the silking period. Data from this trial indicated that a treatment made as the tassels appear followed by a second application just as the first silks appear should effectively protect the ears from fall armyworms migrating from the tassels.

3—Concentrated DDT emulsions containing 2 percent DDT were tested. The sprays were applied to the silks at the rate of 1.22 cc per ear with a hand atomizer, and as atomized sprays with power sprayers at 10 gallons per acre. These experiments indicated that 3 treatments at 5 day intervals of concentrated DDT emulsions so applied were equal in corn earworm control to DDT dusts applied at 3 day intervals during the silking period, but were not equal in control to one properly timed application of atomized DDT-oil spray. The concentrated DDT emulsion was highly effective in controlling the fall armyworm during its migration from the tassels to the ears, but was not a satisfactory control for corn-silk flies.

4—DDT in mineral oil emulsified in water to contain 2 percent DDT and 20 percent oil applied to the silks as an atomized spray showed promise of effective control with no tip damage to the ears. Thirty gallons per acre were applied at 2 day intervals during the silking period for a total of 4 applications.

5—One quart of 25 percent DDT emulsion plus 1 pint of 74 percent chlordane emulsion per 100 gallons of water applied to one acre at 3 day intervals during the silking period for a total of 4 treatments gave control equal to 5 percent DDT dust, but was inferior to 3 quarts of 25 percent DDT emulsion plus 1 quart of 74 percent chlordane emulsion per 100 gallons water. The latter treatment gave good control, however, it caused some damage to the tips of the ears.

6—Two percent parathion dust was superior

to 5 percent DDT dust in controlling the corn earworm and the corn-silk fly, and gave excellent control of the fall armyworm. The possibility of toxic residues and the exposure of laborers to parathion during harvest is not well enough understood to permit this treatment.

7—In preliminary cage trials with adult corn-silk flies, 2 percent parathion dust gave the best knock-down, followed by 5 percent chlordane and 5 percent DDT in the order named. Field observations showed that DDT was not satisfactory in corn-silk fly control. Several field trials were made in order to determine the value of chlordane in corn-silk fly control. From these preliminary trials it appears that one to two applications of chlordane spray or dust made when the tassels begin to appear and before the silks form results in excellent control by killing the adult flies before they have an opportunity to deposit eggs upon the silks. This treatment has been very effective in large plantings, but may not be as effective in small plantings where border migration may be excessive. Under such conditions additional chlordane treatments during the silking period may be required.

8—Two percent parathion dust in cage trials with corn earworm moths gave 75 percent mortality 5 days after the treatment was made. Five percent DDT, 10 percent toxaphene, 5 percent chlordane and 2.5 percent compound 118, were also tried but were not effective.

9—A knapsack type atomized spray applicator was constructed and tested for treating the silks of sweet corn. A one gallon can was swung from the shoulder at hip level. A rubber hose 3 feet long was connected to the bottom of the container and the other end of the hose was connected to a Cornelius Model A hand atomizer. The spray fed by gravity into the atomizer which delivered about 0.6 cc of spray per stroke of the piston. This inexpensive applicator proved very effective. Silks were treated with a single stroke of the piston from each side of the row.

10—A conventional type high clearance, high gallonage, power sprayer was changed over to a low gallonage atomized spray applicator by simply changing nozzles, inserting an extra fine strainer in the line, and arranging for a by-pass for the pump. Since high gallonage spraying is recommended for budworm control a high clearance sprayer with tank and pump capacity for applying a maximum of 125 gallons of spray per acre, and the necessary atomizing nozzles,, screens, etc., for conversion to low gallonage application appears to be the most feasible arrangement for those who contemplate building specialized equipment for treating sweet corn. A machine of this type could take care of the corn from germination to harvest.

Discussion

While atomized sprays containing DDT and mineral oil have shown definite promise in obtaining control superior to any of the dusts tested, this method of treatment must receive further study before general recommendations can be made. Properly timed mineral oil-DDT solutions have been extremely effective, but it has been difficult to avoid excessive tip damage. DDT-mineral oil emulsions are not quite so effective as the solutions, but may prove of more practical value since several applications can be made during the critical period of silking without excessive tip damage.

Blanchard, Douglas, and Wene have reported the progress of their work with atomized sprays which describe the use of oil solutions and emulsions containing DDT based upon studies made during the years 1945 to 1948, inclusive. This report may be obtained from the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine as Mimeographed Report E-780, entitled "DDT Sprays for Control of the Corn Earworm and Budworm in Sweet Corn."

A Suggested Control Program for the Season 1949-1950

If budworms are present when the tassels begin to show apply 30 to 35 pounds per acre of 5 percent DDT dust. Heavy infestations require a second treatment 2 to 3 days later,

and if corn-silk flies are present 3 percent chlordane should be added to the 5 percent DDT. It is important that the first application be made before any silks have appeared.

When about 25 percent of the silks have appeared apply 30 to 35 pounds per acre of 5 percent DDT dust, and repeat at 3 day intervals until the silks have wilted and are turning brown. Four to six applications will be necessary and should be applied in the late afternoon or early morning. Use ground equipment if possible, and direct the dust at the silks.

In the Everglades area sweet corn should be planted as early as possible in order to escape the severe corn earworm infestations which often develop in the late spring. The control program suggested above will give effective results where the infestation of corn earworms is light to moderate, but will be only partially effective when heavy populations exist.

DITHANE DUST INDICATES EFFECTIVE CONTROL OF MELON WORM AND PICKLE WORM

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During insecticide tests on late cucumbers in the Lake Worth area it was found that the fungicide Dithane Z-78, applied as dust containing 6.5 percent active ingredient for control of powdery and downy mildew, had apparently greatly reduced the population of melon worm, *Diaphania hyalinata* (L), and pickle worm, *Diaphania nitidalis* (Stoll). The reduction of melon worms was more readily observed because of the leaf feeding habit of that species. The mortality of pickle worm was not so easily observed, but injury by the latter species was conspicuously slight in Dithane treated plots in comparison with untreated buffer areas. The reduction of *Diaphania* larvae was so striking in the control plots where Dithane alone was used that contamination by some insecticidal material was suspected. As a consequence of the high degree of mortality obtained with the fungicide it seemed desirable to test the material to determine whether contamination was involved or if decided insecticidal properties were possessed by the Dithane. Three small scale experiments were therefore designed in order to answer these questions.

The initial trial, in which the possibility of insecticidal action of Dithane was noted, was a replicated insecticidal experiment on cucumbers established in the Lake Worth area in the spring of 1949. Ten percent

TABLE 1.
A COMPARISON OF DITHANE ALONE WITH FORMULATIONS CONTAINING INSECTICIDES IN CONTROLLING DIAPHANIA LARVAE ON CUCUMBERS

Material	Percent Worm Free Cucumbers Picking							
	1st	2nd	3rd	4th	5th	6th	7th	Average
Dithane Z-78 10%	94.50	94.80	98.89	99.36	94.98	93.83	94 59	95.85
Cryolite 30% Dithane 10%	96.20	81.82	92.91	89.42	89.44	89.83	87.83	89.64
Purified DDT—3% Dithane 10%	100.00	99 16	99.26	100.00	99.69	98.20	98.43	99.25
Parathion 1% Dithane 10%	100.00	97.05	92.92	92.76	97.82	93.20	93.82	95.36
Lindane 1.5% Gamma Dithane 10%	100.00	100.00	99.43	99.81	99.76	100.00	99.34	99.76
Lindane 1.5% Gamma Dithane 10% C-P5 Sticker	100.00	100.00	100.00	99.73	99.72	100.00	99 69	99.87
No treatment (unreplicated)	47.09	54.67	62.97	54.95	60.70	47.68	48.00	53.72

Dithane Z-78 was included in each dust formulation with the insecticide and the check plots received a 10 percent Dithane Z-78 dust. Several outside buffer rows received no treatment. The formulations listed in Table 1 were applied each week at the rate of 30 pounds per acre with a rotary type hand duster. The cucumbers were harvested in seven pickings and examined for damage due to melon worms and pickle worms. Data obtained from this experiment are recorded in Table 1. Most of the insecticidal data is of relatively little value due to the inclusion of the fungicide in each formulation. It does show, however, that Dithane Z-78 used alone compared favorably with formulations in which an insecticide was included in control of *Diaphania* larvae. Formulations containing lindane and DDT were consistently somewhat superior to Dithane in producing mortality. Dithane alone was more lethal to the worms than formulations containing either parathion or cryolite. The cryolite formulation was consistently so much lower in its killing properties than the other materials that explanation is difficult to make in view of the fact that all materials were formulated to consist of 10 percent Dithane Z-78. The dithiocarbamates have been considered compatible with cryolite. The comparatively high percentage of wormy fruit on untreated buffer areas indicated that all treatments resulted in good control. Since the Dithane dust used alone resulted in good control of *Diaphania* larvae further investigations were made.

Experiment No. 1

Five squash plants having a fairly heavy melon worm population were selected and pre-application worm counts were made. Dithane dust from the same source as that used in the cucumber tests was applied at approximately 35 pounds per acre. (Counts were made on three untreated plants for comparison.) The results of this small test (Table 2) were indicative of the same lethal action on melon worm as previously noted in the cucumber tests. Thirty hours after the Dithane treatment 94.6 percent mortality was obtained.

Experiment No. 2

In order to determine whether or not the Dithane was contaminated during formulation, a second preliminary test was conducted in which a freshly and carefully formulated 10 percent Dithane Z-78 dust was prepared from the same stock of materials as that used for the cucumber trials. Seven infested squash plants were selected, pre-application counts made, and the material applied. Comparative counts were made on five untreated plants. The results again indicated excellent control of melon worms. A mortality of 96.3 percent resulted on the treated plants within 30 hours. The data is included in Table 2.

TABLE 2.
EFFECT OF 10 PERCENT DITHANE Z-78 DUST ON MELON WORMS ATTACKING SQUASH

Treatment	Average No. Melon Worms Per Plant Before Application	8 Hours After Application	30 Hrs. After Application
Experiment I			
1—Dithane Z-78 dust (Formulation No. 1)	14.6	7.2	0.8
2—Check—Not treated	10.0	9.7	10.8
Experiment II			
1—Dithane Z-78 dust (Formulation No. 2)	3.8	2.1	0.1
2—Check—Not treated	3.0	3.0	2.8

Experiment No. 3

It was now deemed advisable to test Dithane Z-78 from another source in order to investigate the possibility of contamination during manufacture, storage, or subsequent handling of the materials making up previous formulations. Upon suggestion* it was also decided to use two diluents of different pH value to gain an indication of the possible implication of this factor in the lethal action of the fungicide. Kaolin velvex diluent of fairly low pH was used in one case and Pyrax diluent, almost neutral in reaction, was used

Formulation No. 1	pH
Kaolin Velvex diluent	5.1
Dithane	5.0
Diluent-Dithane mixture	4.6

The reaction of the formulated dust was lower than either that of the Dithane or the diluent in this instance.

Formulation No. 2	
Pyrax diluent	6.9
Dithane	5.0
Diluent-Dithane mixture	5.5

in the other instance. The reaction of each ingredient and the formulated dusts follows.

The only plants available when this test was conducted were a few volunteer cucumber plants with a rather low melon worm population. All worms seemed in healthy condition at time of treatment. The pre-application counts were made and all infested plants marked with a stake. Nine plants were treated with 10 percent Dithane Z-78 in Kaolin diluent and nine others with 10 percent Dithane Z-78 in Pyrax diluent. Counts made on 5 untreated plants served as a check. Both treatments indicated a high degree of mortality and the data given in Table 3 was obtained.

TABLE 3.
EFFECT ON MELON WORMS OF 10 PERCENT Z-78 DUST FORMULATED WITH PYRAX AND KAOLIN DILUENTS

	Avg. No. Melon Worms Per Plant		
		5 Hours	20 Hours
Treatment	Before Application	After Application	After Application
1—Dithane in Kaolin Velvex diluent	2.1	0.7	0.1
2—Dithane in Pyrax diluent	1.3	0.7	0.1
3—Check—No treatment	2.2	2.2	2.0

The Kaolin-Dithane formulation gave a mortality of 94.7 percent in 36 hours, while the Pyrax-Dithane formulation gave 91.7 percent kill over the same period, thus no appreciable difference was indicated within the pH ranges used in this small test.

During these tests it was noted that the high temperatures obtaining in the field seemed to speed the lethal action of the Dithane, as compared to the relatively cooler temperatures involved in indoor laboratory tests, not here reported. To produce mortality percentages approximating those produced on the insects on field plants an additional 24 to 48 hours was required in the indoor tests. It seemed that the mortality by Dithane may have been a combination of contact–fumigant action. Worms that were not quickly affected seemed to be considerably repelled as shown by a desertion of the foliage in a number of cases. If the adult moth is repelled lighter oviposition activity may result as an additional benefit to Dithane treated plants. Larvae in the field did not seem to be repelled, perhaps due to the quicker action of the material at field temperatures.

Summary

Ten percent Dithane Z-78 dust appears to possess strong insecticidal properties as indicated by the consistently high mortality of *Diaphania* larvae following applications of several different formulations of this material. Some repellency is also indicated as shown by the insects rapid desertion of certain treated foliage. Mortality appears to be due to contact action. Dithane or other identical materials under different trade names should be further tested against other lepidopterous species. While in all tests the insecticidal properties of Dithane Z-78 seemed specific, since no other insects were found to be affected, further investigation of this fungicide against other lepidopterous larvae seems to have merit. Entomologists should bear in mind the possible insecticidal action of Dithane when used in test work, otherwise much misleading data could result.

*Acknowledgment is made to Mr. C. F. Ladeburg for his cooperation and assistance in preparing the formulations used in this trial.

SPRAY RESIDUES AND THE FEDERAL FOOD, DRUG, AND COSMETIC ACT

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The present Federal Food, Drug, & Cosmetic Act was passed by Congress in 1938 as a successor to the old Food & Drug act of 1906. In the reports made in connection with the passage of the law, Congress made plain its intention to increase its protection of the consumers. The law, which has as its objective

the public welfare, is based on the commerce clause of the constitution and prohibits the introduction in interstate commerce any food, drug, or cosmetic that is adulterated or misbranded. Interstate commerce is defined as traffic between the states and any point outside, and thus covers in addition to traffic between the states, shipments from foreign countries and to foreign countries.

The law also prohibits the doing of any act which would result in a food being adulterated or misbranded while held for sale after shipment in interstate commerce. The law provides for enforcement in the Federal Courts by criminal prosecution of persons violating the act, seizure and condemnation of the violative articles, and injunctions to restrain violations.

Congress has defined "adulteration" and "misbranding." I will mention only those definitions which are applicable to our mutual problems, the possible adulteration of food through the use of pesticides. The law states that food shall be considered adulterated if it contains a poisonous or deleterious substance which may render it injurious to health. This definition is amplified by another section which states that any poisonous or deleterious substance added to any food shall be deemed to be unsafe for the purpose of application of this clause, except where such substance is required in the production of the food, or cannot be avoided by good manufacturing practice.

The application of these sections may be illustrated by considering the fact that certain seafoods contain small amounts of arsenic. However, since the arsenic is not an added substance, such food shall not be considered adulterated if the quantity of arsenic is so small that it does not render the seafood injurious to health. On the other hand, other shellfish, such as clams from certain areas, contain a poisonous toxin in amounts capable of causing illness or death, and such food would be adulterated even though the poisonous substance is not *added*.

To illustrate the position of the law with respect to *added* poisons, we may consider the position of monochloracetic acid added to wine and beer. Since it cannot be shown that this substance is required in the production of these foods, and no one can show that it cannot be avoided, these foods would be considered adulterated if they contained these poisonous or deleterious substances in any amount because they are *added*.

On the other hand it has been shown that in some areas it was necessary to spray apples and pears with lead arsenate. While most spraying schedules are directed to result in little or no residue at the time of marketing, in certain sections when this chemical was applied with binders, there were residues in varying amounts. However, if it appears that the use of the lead arsenate could not be avoided and was necessary for the production of the crops, then the law provides that the Administrator shall promulgate regulations limiting the quantity in or on the food to such extent as he finds it necessary for the protection of public health, and any quantity exceeding such fixed limits shall be deemed unsafe, and the article classed as adulterated in violation of the law.

This limit to be fixed by the Administrator is what is known as the tolerance. To date only one tolerance has been promulgated under this section of the law. That tolerance was for fluorine in apples and pears, and it has been set aside by the Courts because the regulations as promulgated described the poison as "fluorine" instead of "Fluorine Compound." Therefore, there are no official tolerances under this section of the law at the present time.

The Food & Drug Administration has announced a hearing for the purpose of considering tolerances for certain poisonous and deleterious residues on fresh fruits and vegetables for January 17, 1950. That Congress had in mind the protection of consumers in the adoption of such tolerances as indicated by the wording of the section which says, "In determining the quantity of such added substance to be tolerated in or on different articles of food, the Administrator shall take into account the extent to which the use of such substance is required or cannot be avoided in

the production of such article, and the other ways in which the consumer may be affected by the same or other poisonous or deleterious substances." For example, about twenty years ago, we found apples from the Pacific coast, celery from Florida, and cabbage from South Carolina, all in the same market and containing excessive amounts of lead arsenate.

Another point which must be considered in establishing tolerance for a poison in or on food is that the food may be eaten by young and old ,weak and strong, and continued over long periods of time without the knowledge of the person that he is taking small amounts of poison. Sometimes people have called our attention to the use of arsenic in medicine and to the fact that doses given exceeded the suggested limits for fruits and vegetables. However, it should be considered that in prescribing arsenic, a physician is giving a definite amount for a definite time to treat a certain condition which he has diagnosed as one which may be relieved by such treatment. The physician knows that arsenic is a poison with deleterious effects, but based on experience is justified in taking a calculated risk because the benefits expected outweigh the possible adverse effect. On the other hand, the Food Law Enforcement Official, charged with the protection of the consuming public has to consider the deleterious effect of the long time use of such contaminated food products and the fact that the insidious damage which may be caused will not be recognized until too late to help the victim. The securing of data on the effects of poisons, especially the chronic long time effects of small amounts is a very difficult matter. Naturally most of the work must be done on small animals and conclusions drawn as to the possible effects on human beings. In the cases of lead and arsenic, there have been reported observations of the effects of these substances on human beings which can be considered in connection with the results on the small animals. These data may be sufficient to permit the establishment of tolerances for lead, arsenic, and fluorine.

The Commissioner of Foods & Drugs, Dr. Paul B. Dunbar, has recently pointed out some of the difficulties encountered in connection with the new and very powerful insecticides. In addition to the lead, arsenic, and fluorine, he believes that there is now sufficient scientific evidence, through our own investigations and the work of other researchers, to establish tolerances, after formal hearings on D D T and parathion, and perhaps a number of other comparable insecticides. It may take years to secure enough data to determine safe limits for residues of some of the newer agricultural pesticides.

Since we are faced with this situation, it is to our mutual interest that such pesticides be carefully evaluated from the standpoint of safety of the consumer of food, and not used excepting under such conditions which will result in their being absent from the food at the time it is marketed for consumption. The manufacturers of these pesticides are in many cases doing research work on the toxicity of these chemicals from the standpoint of the food consumer, in addition to other research work on the effect of the chemicals on the plants and their pests.

While the entomologist appreciates these points, he often has a problem of getting the enthusiastic grower, who sees the striking results of the new chemicals, to carefully follow the recommended time schedules for spraying. Also there is always the problem of the poorly informed person who concludes that if a little of a substance is good, a greater amount must be better. Such reckless use of pesticides may cause serious injury to consumers and the loss of confidence in the product. It is therefore to our interest that growers, entomologists, and health and food officials work as a team to insure that the crops which go to consumers, are safe.

PRECAUTIONS TO BE EXERCISED IN USING ORGANIC INSECTICIDES ON VEGETABLE CROPS

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In presenting this subject at this time it is my purpose to call attention to the dangers involved in the use of the organic insecticides available since 1945 and to emphasize the precautions which should be rigidly practiced in the use of these insecticides.

Everyone is aware that the effectiveness of an insecticide depends upon its ability to kill insects. Most growers also know that these effective insecticides are harmful to man. Two of the oldest insecticides, nicotine and arsenate of lead, are violent poisons and have caused human deaths when carelessly handled. It is my firm opinion that we should not discard these materials simply because they are capable of causing human death in careless hands. No one advocates discontinuing the use of automobiles. Yet automobiles are directly responsible for thousands of human deaths each year. If, then we are to continue to use these poisonous insecticides we must constantly and carefully practice the necessary precautions.

In 1925 the apple growers of the United States were forcibly reminded of their responsibility for excessive residues of arsenicals on their apples by the refusal of the British Government to allow entry into England to apples carrying a residue in excess of tolerances established earlier. In 1926 the celery growers of the Sanford area were amazed to find one morning that their unwashed celery could not be shipped to market because it had been found to be carrying arsenical residue in excess of the established residue tolerances. The use of arsenicals in vegetable production has been discontinued since the introduction of synthetic organic insecticides beginning in 1945. Since information upon which to base the establishment of tolerance for organic insecticides has not been available no tolerance levels for these materials has been established. Thus growers have had a period of several years during which they have not worried about insecticidal residues on their crops. This period is rapidly drawing to a close because the Pure Food and Drug Administration has called a hearing in January for the purpose of gathering information which will be used in establishing tolerance levels for the various insecticides. As many of you know, some canners and food processors have already declared that vegetables known to have been treated with some insecticides will not be purchased. In addition to his responsibility to the consumers of vegetables, the grower has a responsibility to his laborers and himself to consider in the use of these poisonous insecticides. It is time for vegetable growers to again begin to think seriously of these responsibilities.

Considerable time is required to accurately evaluate the potential dangers of insecticide residues, involving as it does studies of acute and chronic oral and external surface toxicity, biochemical studies with special emphasis on absorption, distribution and excretion, and the pathological effect of various poisons upon the organs of the body. Of course, these studies must be conducted upon laboratory animals and for this reason the exact effect of these materials upon humans cannot be accurately determined. However, as accidents occur a knowledge of the reaction of the human body is gradually built up to supplement the knowledge gained from laboratory studies.

With the above factors in mind I shall briefly review the information accumulated on the toxic effects of the organic insecticides. A number of research workers have been intensively studying the many phases of the problems of toxicity of these materials. Practically all of the information given below has been taken from two papers published by

Lehman. In the following discussion it should be remembered that the statements refer to reactions of laboratory animals produced by chemicals of high purity as such or in an innocuous solvent. There are thousands of formulations of probably not more than twenty-five insecticides. The solvents, diluents, wetting agents and carriers used in these formulations may be solely responsible for injuries and it is often impossible to determine which of these ingredients should be incriminated. For this reason chemicals of high purity were used in the laboratory experiments.

At the present time there are three insecticides derived from vegetable sources in common use. These are derris, pyrethrum and nicotine. The insecticidal quality of derris is due to a number of constituents, the principal one being rotenone. Rotenone applied to the skin occasionally produces a mild irritation which persists about twenty-four hours after the removal of the causative agent. Irritation of the mucous membranes of the nose and eye are caused by contact but no permanent injury has been reported. Rotenone is not absorbed by the skin. The fatal dose is probably quite large. It has been shown that finely powdered rotenone is about six times as poisonous as coarse crystals and that the intravenous toxicity is three to eight thousand times the oral toxicity. It has also been shown that finely powdered rotenone has a toxicity of approximately the same order as intravenous injections. It can be seen that the inhalation of finely ground rotenone or derris can be very serious.

The active constituents of pyrethrum are called pyrethrins. The highest concentrations in commercial use are twenty percent pyrethrum extracts in oil. The single acute oral dose is quite large in animals. Household preparations of pyrethrum are usually in kerosene. Toxic effects following the accidental swallowing of these preparations would be due to the effects of the kerosene.

Nicotine is a very volatile liquid alkaloid. Nicotine 80 contains 80 percent of the alkaloid. The other liquid form of nicotine on the market contains 40 percent nicotine sulfate. Nicotine alkaloid penetrates the skin very readily while the sulfate does not. For this reason nicotine 80 is very dangerous to handle. Nicotine is one of the most rapid and deadly poisons known to man.

The remaining insecticides are known as synthetic organic chemicals. These include lethanes, DDT, TDE, methoxychlor, clordane, benzene hexachloride, toxahene, tetra ethyl pyrophosphate, parathion, Compound 118 and Compound 497. The latter two materials are so new that they have not yet been given names and they are not at present on the market.

There are four materials on the market which have as their active ingredients aliphatic thiocyanates. These four materials are grouped together under the name lethanes. The lethanes are dissolved in refined kerosene at concentrations of 2 and 3 percent of the active ingredient. Thus the local effects produced by the lethane solutions are due to the kerosene. Concentrated solutions containing 50 percent lethanes are also available. A small dose of these concentrates taken internally will result in death within a few minutes.

This brings us to the DDT group which also includes TDE (Rothane) and methoxychlor. DDT crystals do not affect the skin but solutions of DDT are absorbed through the skin and multiple exposures by spilling the solutions of DDT on the body are hazardous. The amount of DDT required to cause death by a single dose taken internally by man is not known. Methoxychlor is only slightly irritating to the skin when applied in the crystalline form. Like DDT, solutions of Methoxychlor are absorbed through the skin. Rothane, like Methoxychlor, is slightly irritating to the skin and oil solutions are absorbed through the skin.

Chlordane is a complex chemical compound composed of several closely related chemicals. Concentrated commercial chlordane is moderately irritating to the skin but in insecticidal dilutions this property is lost. Chlordane in solution is absorbed through the skin. Chlordane is rated to be about five times as poisonous as DDT.

Benzene hexachloride is another of the complex chlorinated hydrocarbon compounds. The

gamma isomer of Benzene hexachloride is the principal insecticidal agent and the combination with the other three isomers is a skin irritant. The damage caused is in direct proportion to the amount of the gamma isomer in the mixture. Repeated application of benzene hexachloride increases the toxic effect by 200 fold. When taken internally three of the isomers of benzene hexachloride act as central nervous stimulants while the other isomer acts as a depressant. Benzene hexachloride is rated as about twice as poisonous as DDT.

Toxaphene is a chlorinated derivative of camphene which is a by-product of naval stores manufacture. Toxaphene is moderately irritating to the skin and it can be absorbed through the skin in dangerous quantities. Toxaphene is about four times as poisonous as DDT when taken internally.

The two important members of the organic phosphate group are tetra ethyl pyrophosphate known as TEPP and parathion. TEPP is the most dangerous of all of the insecticides because it is rapidly absorbed through the skin and is capable of causing death in very small quantities. As little as one small drop splashed into the eye may be fatal. A number of deaths have resulted from the breathing of the dust or spray mist of Parathion.

To the present time only preliminary results from the investigations of Compounds 118 and 497 have been reported. These preliminary results indicate that both of these compounds are readily absorbed through the skin and that they are very poisonous to man.

From the standpoint of the single acute dose these insecticides have been tentatively classified in the order of their relative hazards to public health. This arrangement with the most poisonous material first follows: TEPP–Parathion Compound 497 – Nicotine – Compound 118–Chlordane–Toxaphene–DDT– Rotenone –Lethane 384–Lethane 384 special–Benzene hexachloride–Lethane 60–Thanite–Rothane– and Methoxychlor. The toxicity of pyrethrum and the inert activators N-propyl isome and piperonyl butoxide is so low that the danger from taking an injurious amount of these materials appears to be very small.

The matter of chronic toxicity or the eating of small quantities of these chemicals as residues on one or more food substances is quite a different problem. One of the complicating factors is that many of our foods, particularly vegetables, may carry small amounts of these poisons as residues. An attempt has been made to evaluate the relative dangers from these poisons as spray residue contamination of food. This comparative rating has been made under the assumption that a single item of food is contaminated. The rating is expressed in parts per million of the smallest amount of the insecticide which will cause toxic effects. This rating is as follows:

Rotenone–5 parts per million.

Pyrethrins–10 parts per million.

TEPP–Rapidly decomposes; known decomposition products not considered hazardous.

Parathion–2 parts per million.

DDT–Less than 1 part per million if all the food is contaminated; 5 parts per million if only one item of food is contaminated.

Benzene hexachloride–Similar to DDT.

Chlordane–Similar to DDT.

Toxaphene–Probably 5 parts per million.

Rothane–Probably 5 parts per million.

Methoxychlor–Probably 10 parts per million.

N-propyl isome–10 parts per million.

Piperonyl butoxide–10 parts per million.

A very considerable amount of information has been accumulated on the amount of DDT residue remaining on vegetables grown in other states and treated with the various formulations of this insecticide. It is necessary that as soon as possible this type of information be gathered for vegetables grown in Florida. The information available from work done in other states does not apply to Florida grown vegetables because our vegetables are produced under entirely different temperature, sunlight and rainfall conditions. These factors greatly influence the amount of insecticidal residues remaining on vegetable crops as well as the concentration and number of applications of the insecticide and the length of the period between the last application and harvest. The Experiment Station now has two chemists, one

located at the Everglades Station and one at the Central Florida Station, studying these residue problems. Through the work of these chemists cooperating with the entomologists of these Stations information is being gathered as rapidly as possible.

In the meantime there are precautions that vegetable growers can and should put into practice, to safeguard the health of vegetable consumers, his laborers and himself. These precautions are separated into two groups; those for the protection of consumers of vegetables and those for the protection of the grower and his laborers. Under the first group:

(1) Do not use greater concentrations of the insecticide than is required.

(2) Familiarize yourself with the insect to be controlled and make no more applications than necessary.

(3) Keep your crops free of insects during the early stages of growth and usually no insecticide application will be required within 30 days of harvest.

(4) Do not apply parathion or any of the chlorinated hydrocarbon insecticides within 30 days of harvest.

(5) If an application of an insecticide is required within 30 days of harvest use TEPP or pyrethrum.

Under the second group:

(1) Do not spill liquid insecticides on clothing or the body.

(2) After completing a spray or dust operation take a bath and change to fresh clothing.

(3) Avoid the dust or spray mist produced by the application of insecticides.

(4) Read the labels on the container to become familiar with the chemical being used.

(5) In transferring insecticides from the container to the spray or dust machinery, stand on the up wind side of the machinery.

(6) If insecticides are accidentally spilled upon the clothing or the body, remove the clothing immediately and scrub the body vigorously with soap and water.

(7) In case symptoms resulting from the use of insecticides develop see a doctor immediately.

(8) While spraying or dusting wear a suitable gas mask. The ordinary dust mask is not effective.

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COMPATABILITY OF SPRAY MATERIALS

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Bradenton

Florida's mild climate makes possible the growing of winter vegetables, but also provides ideal conditions for the development of many insect pests throughout the annual cycle. The Gulf and Atlantic Ocean, which keep our summer temperatures down and our winter temperatures up, also keep air humidity at a high level and thus favor the development of various plant disease organisms. And our heavily leached soils are all low in one or more of the nutrients essential to heavy production of vegetable crops. Certain of these nutrients can be supplied economically in small amounts to the foliage of growing crops by means of sprays.

It is possible to apply these insecticides, fungicides and nutrients separately, of course, and we know pretty well what we can expect from them when applied in this manner. We also know from experience and from reports by manufacturers that certain combinations of materials are reasonably safe and effective. And we know that it is cheaper to apply them in combination.

Much valuable testing is done by commercial companies long before their products appear on the market. Some of these companies

have worked on the compatibility of their products with other chemicals, and have made available to dealers and growers charts which indicate which chemicals may be mixed in the same spray tanks. These charts are generally dependable, but no combination can be considered as absolutely safe on all crops or in all seasons unless they are actually tested under a variety of conditions.

Damage to crops by foliage burn or by reduction in yield is only one of three possible ways in which two or more materials can be incompatible. It is possible—and this is especially true of some of the organic materials—for a second material to change the chemical structure of the first, so that an insecticide or fungicide may be rendered ineffective. Finally, a combination may change physical properties, so that the mixture may plug up spray nozzles, settle out too quickly or gum up spray tanks.

In many cases, certain combinations thought to be safe have burned our crops. In many cases, too, growers have combined as many as four and five materials without apparent damage. We get so many questions at the Experiment Station as to safe and effective mixtures that we embarked on a research program to study these things last year. This preliminary report is an outgrowth of this work.

Materials Tested

Six insecticides, six fungicides and four nutrient materials were tested last spring in all possible combinations on peppers and tomatoes. The insecticide and fungicide combinations were tested on pole beans. The actual materials tested are listed in Table 1.

The experiment on each crop was designed so that data secured on yields (or other data) could be analyzed by approved statistical methods. The experimental design was the type which permits the evaluation of effects caused by combinations of factors, which, of course, was the basic purpose of the test.

Before considering the results secured, it should be recalled that spring 1949 crops grew under abnormal drouth conditions, and with abnormally high temperatures. At Bradenton, for the five months of January through May, only 3.68 inches of rain were recorded as against a normal of 13.55 inches, for a deficit of almost ten inches. None of the rains which came during this period were heavy enough to leach out our soils. The heaviest was considerably less than one inch.

In comparing temperatures, January was 6.9° above normal, February 8.1°, March 2.4°, April .9° and May 2.3°. These were record-breaking excesses.

With no leaching rains occurring, irrigation was general and available fertilizer nutrients built up rapidly as a result of fertilizer additions and oxidation of soil organic matter. Nitrates up to several hundred parts per million were common on sandy soils, whereas levels of 50 or 60 p.p.m are considered adequate. As a result of high temperatures and high fertility levels, tomato, pepper and bean plants grew vigorously and were very succulent. They were abnormally susceptible to wind-burn, and proved extremely sensitive to damage by spray materials. These effects of weather must be considered when the results of these experiments are described.

Table 1 is an abbreviated table in which the averages of leaf-roll ratings of tomatoes by three observers are entered. Leaf roll developed rapidly after the application of the first combination sprays, and the amount of roll correlated with actual damage to the leaves. This damage in some cases was a definite burning, in others a chlorosis, and in still others a spotting of the foliage.

All plants subsequently recovered in some degree from the effects of this spraying, and yield data from these plots failed to show as marked differences as developed in the leaf roll data. The only chemical which actually reduced leaf roll when applied as a spray in this test was manganese sulphate; this also was the only chemical which significantly increased the yields of marketable fruit. The soil was known to be high in pH (around pH 7.0) and deficient in manganese.

Rhothane was the only insecticide which did not affect leaf roll; its continued use, however, decreased yields, as did all insecticides

used. Phygon, similarly, was the only fungicide which did not affect leaf roll. Again, continued use of this material reduced yields, as did all other fungicides. Because of the nature of the season, neither disease nor insect pests were serious, and under these conditions their continued use decreased yields. This freedom from disease and insect pests occurs so seldom in Florida that we have no slightest intention of suggesting that use of either class of materials be stopped; however, for our purpose of evaluating phytotoxic effects it was ideal.

Some of the conclusions drawn from the data of Table 1 on leaf-roll are as follows, and can be picked up by observing the totals on the table:

a) Parzate and either toxaphene or parathion were incompatible.

b) Phygon and DDT were incompatible.

c) Copper-A compound and either iron sulphate or zinc sulphate were incompatible.

d) None of the nutrient sulphates were compatible with Phygon.

e) All of the nutrient sulphates were compatible with Dithane D-14 plus zinc sulphate (although this fungicide severely rolled the leaves in this test).

f) Zinc sulphate and parathion were incompatible.

g) Iron sulphate and DDT were incompatible.

Finally, in some cases the addition of a third chemical actually reduced the apparently

TABLE No. 1

LEAF ROLL RATINGS FOLLOWING SPRAY APPLICATIONS OF MARCH 17, 1949 ON TOMATOES. FUNGICIDES, INSECTICIDES AND NUTRIENTS APPLIED TOGETHER AS INDICATED. THE HIGHER THE RATING, THE MORE PRONOUNCED THE LEAF ROLL[1]

		2 Lbs. 50W DDT	2½ Lbs. 40W Chlordane	2½ Lbs. 40W Toxaphene	2 Lbs. 50W Rhothane	1 Lb. 15W Parathion	Check (No Insecticide)	Total
Parzate (dry)—2 lbs.	Check (no nutrient)	7	11	11	7	13	7	56
	Ferrous sulphate	13	12	13	12	12	14	76
	Manganous sulphate	6	8	10	7	12	7	50
	Zinc sulphate	7	9	11	8	13	8	56
	Sum	33	40	(a)45	34	(a)50	36	238
SR-406—4 lbs.	Check (no nutrient)	12	13	9	9	11	8	62
	Ferrous sulphate	10	9	7	8	9	9	52
	Manganous sulphate	8	10	8	8	10	8	52
	Zinc sulphate	9	12	13	7	13	12	66
	Sum	39	44	37	32	43	37	232
Dithane D14 2 qt. plus zinc sulphate 1 lb.	Check (no nutrient)	11	12	14	9	14	14	74
	Ferrous sulphate	10	13	13	9	13	9	(e)67
	Manganous sulphate	12	12	13	11	13	12	(e)73
	Zinc sulphate	12	13	14	12	14	11	(e)76
	Sum	45	50	54	41	54	46	290
Copper—A Compound 6 lbs.	Check (no nutrient)	8	9	8	8	9	6	48
	Ferrous sulphate	14	14	14	13	14	14	(c)83
	Manganous sulphate	8	9	7	6	7	6	43
	Zinc sulphate	9	9	10	7	14	7	(c)56
	Sum	39	41	39	34	44	33	230
Phygon XL 2 lbs.	Check (no nutrient)	8	7	5	5	7	5	37
	Ferrous sulphate	12	8	7	8	11	7	(d)53
	Manganous sulphate	7	8	9	6	10	5	(d)45
	Zinc sulphate	9	9	6	8	11	7	(d)50
	Sum	(b)36	32	27	27	39	24	185
Check (no fungicide)	Check (no nutrient)	8	8	7	7	8	5	43
	Ferrous sulphate	7	7	7	8	7	7	43
	Manganous sulphate	6	7	6	6	6	6	37
	Zinc sulphate	8	9	9	6	13	6	51
	Sum	29	31	29	27	34	24	174
All Fungicides	Check (no nutrient)	54	60	54	45	62	45	320
	Ferrous sulphate	(g)66	63	51	58	66	60	374
	Manganous sulphate	47	54	53	44	58	44	300
	Zinc sulphate	54	61	63	48	(f)78	51	355
	Total	221	238	231	195	264	200	1349

[1]Amounts per 100 gal. of spray are indicated in Table.

toxic effects of a combination of two incompatible materials. For example, manganese sulphate, added to the chlordane—Parzate mixture, actually and significantly reduced the amount of leaf roll. Results of this kind at first glance confuse the picture. The only possible answer is that all three types of materials—insecticides, fungicides and nutrients—have important effects on the normal balanced nutrition of the plant. Since this is so, and since both classes of pesticides are essentially poisons, such materials usually have deleterious effects on plants, and their application is in the nature of a necessary evil. With some crops and on some soils, however, pesticides have beneficial nutritional effects.

Because of this, the "incompatibilities" listed above should not be taken too seriously; the data are all from one set of seasonal conditions. We hope that they will serve to emphasize the point that disease and insect control should be handled on a common sense basis. The tendency toward excessive spraying may mean fewer bushels of fruit per acre, perhaps serious damage to the crop. A proper spray program makes use of the minimum number of applications of pesticides for control of such diseases and insects as may be present or threaten. Only careful, daily observation by the grower can properly decide the need for pesticides. A minimum protective schedule, with increased frequency only if pests or diseases appear, is safer than too frequent spraying.

FERTILIZING CELERY ON THE SARASOTA MUCKLAND

By Ernest L. Spencer and D. S. Burgis

Florida Agricultural Experiment Stations
Vegetable Crops Laboratory

Bradenton

Celery production in Florida is concentrated, for the most part, in muckland areas near Belle Glade, Oviedo, Sarasota, and Zellwood. Of the muck areas, the oldest in production is probably the Sarasota section, having been drained for the production of celery in the 1920's. Farming on the Sarasota muck is very intensive, being confined to about 1400 acres, with no possibility of acreage expansion as practically all the muckland is now utilized for celery.

In the spring of 1948, hundreds of acres of celery in the Sarasota area were plowed under without any attempt being made to harvest the crop. Part of this loss was attributed to mosaic but most of it was caused by blackheart. This disorder is considered a physiological or non-parasitic disease, since no organism has been shown to be associated with it or related in any way with its appearance.

A preliminary survey of the area was made at that time and many soil samples taken in an effort to determine if this severe outbreak of blackheart could be attributed to any definite fertilizer practice. Generally speaking, soil acidity differences were slight, potash was very high and phosphoric acid was low to medium in all samples. One lead was found which may be of considerable importance. It was noted that the contents of nitrate nitrogen and total soluble salts were high wherever blackheart was severe. It seems rather unlikely that a high concentration of nitrate nitrogen would be toxic in itself, but it may lead to an injurious condition following a heavy rain which, as noted from experience, usually precedes an outbreak of blackheart by several days.

The usual fertilizer practice in this area has been as follows: (1) Broadcasting 800-1200 pounds per acre of cyanamid for pink rot control several weeks prior to setting; (2) Side-dress with a 5-5-8 fertilizer at the rate of 1000 pounds per acre every three weeks or so during the crop; (3) Top-dress with 200 pounds of nitrate of soda or 500 pounds of a 12-0-10 fertilizer a week or so prior to harvesting.

During the 1948-1949 growing season an extensive series of experiments were carried

out in an effort to study whether or not the fertilizer program as practiced by the growers in this area might be conducive to the production of blackheart. Little or no blackheart appeared in the area during this period so no conclusions could be drawn from these experiments concerning this disorder. It should be noted that weather conditions during this past winter season were somewhat "unusual," in that it was warmer than average. There was also less rainfall, a total of about four inches of rain being recorded for the 6-month period starting in early October.

Moreover, following the heavy financial loss with the spring crop of 1948, many growers decided not to use cyanamid the following year. As has already been stated, cyanamid is usually applied annually by most growers in this section for the control of pink rot, a fungus disease of celery. When properly used, treatment with cyanamid, in quantities ranging from 800 to 2000 pounds per acre, is effective in controlling the disease. Many growers apparently fail to take into account, however, the fertilizing value obtained by the use of cyanamid. The application of 1000 pounds of cyanamid per acre adds approximately 200 pounds of readily available nitrogen. This supply of nitrogen should be considered in planning the fertilizer program for the crop.

Experimental test plots were laid out this past season on fields of four different growers (Clifford A. Childers, R. L. Garrison, Krall & Martin, and Fred Brown). In one series, three levels of nitrogen (1, 5, and 9 percent), three levels of phosphate (0, 8, and 16 percent), and three levels of potash (0, 8, and 16 percent) were studied in all possible combinations, with and without prior treatment with cyanamid for pink rot control. This made 54 plots in each of the four fields.

With regard to nitrogen, the yields in terms of 52-pound field crates per acre were as follows:

Nitrogen Level	With Cyanamid	Without Cyanamid
1%	1085	849
5%	1122	1084
9%	1137	1142

Yields must differ by 41 to be statistically significant at the 5% level.

In the absence of cyanamid yields increased significantly as the nitrogen level in the fertilizer increased. With cyanamid, however, the increase was very slight.

With regard to phosphate and potash, the yields were as follows:

Phosphate Level	Phosphate Yield	Potash Level	Potash Yield
0%	1064	0%	1037
8%	1068	8%	1086
16%	1079	16%	1087

Significant difference at 5% level equals 29.

It is difficult to explain the high yields obtained in the absence of additional phosphate, unless one can assume that there was sufficient residual phosphate in the soil to satisfy the plant requirement. These soils have been cropped continually with celery for many years, each crop receiving from 3000 to 5000 pounds of 5-8-8 or some similar ratio fertilizer per acre. Just how long these soils can be farmed now without additional phosphate is a question. Added potash increased yields as was to be expected.

In another series of plots a test was made of the frequency with which the fertilizer should be applied. The yields were as follows:

Fertilizer	With Cyanamid	Without Cyanamid
Every 3 weeks	1132	1054
Every 4 weeks	1140	959

Significant difference at 5% level equals 47.

On the cyanamid plots fertilizing every four weeks with a total of 3000 pounds per acre produced yields equal to those obtained by fertilizing every three weeks with a total of 4000 pounds per acre. In the absence of cyanamid, fertilizing every three weeks produced the higher yields.

Many growers in this area are of the opinion that a fertilizer high in organic nitrogen is to be preferred to one in which most of the nitrogen is present as mineral nitrogen. This belief was not substantiated in the experimental plots where the yields obtained were as follows: No organic nitrogen—1117 field crates per acre, 40 percent organic nitrogen—1126 field crates. Basic fertilizer applied was 4000 pounds per acre of 5-5-8 in four applications. These results show that no increased yields were obtained by using the fertilizer

with 40 percent organic nitrogen. This might not have been the case with normal seasonal temperature or with normal rainfall.

The belief is commonly held that the continued use of cyanamid will gradually raise the pH to a point that is harmful to celery. In no case was the pH raised more than 0.1 pH unit at time of setting. On one set of plots the pH of the cyanamid-treated plots was 0.2 pH unit lower than that of the non-cyanamid plots.

Celery yields both in the experimental plots and throughout the area were exceptionally high last year. Yields of 1000 field crates or better per acre were the rule rather than the exception.

No definite fertilizer recommendations can be made on the basis of one year's results. It is planned to conduct additional fertilizer tests in this area again. In the meantime, however, it is suggested that growers continue the use of cyanamid where necessary for the control of celery pink rot (see Florida Press Bulletin No. 567), and modify their fertilizer program to compensate, to some extent at least, for the nitrogen added in the cyanamid treatment.

THE EFFECT OF SOIL pH UPON THE GROWTH OF CELERY SEEDLINGS ON THE PEAT AND MUCK SOILS OF THE EVERGLADES

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Florida Agricultural Experiment Stations
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Belle Glade

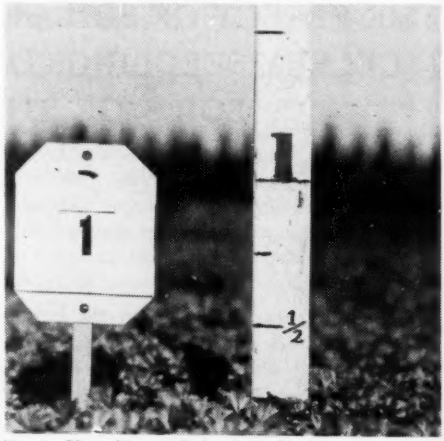
For several years it has been the custom of celery growers in the Everglades to keep their seed bed areas flooded with alternate periods of drying and discing during the late spring and early summer immediately preceding the period of seeding which usually begins in early July. This has been done with the idea that such a treatment should help the control of weeds, grass, soil insects and nematodes. Whether or not this procedure really offers any practical control of their particular problems is still largely a matter of conjecture. Be that as it may, the water used for flooding is usually pumped from open field ditches which lie immediately over or are cut into the lime rock substrata. This water normally carries very large amounts of calcium as well as other bases which are deposited in the soil in substantial quantities due to the comparatively heavy evaporation from such moist soil surfaces during the warm periods of May and June. It has been known for some time that this alternate flooding brings about a gradual increase in soil pH. However, it had been the general opinion that this factor was being taken care of by increasing the manganese and, in some cases, zinc in the fertilizer; also by using a fertilizer slightly higher in phosphates and supplementing the soil applications with nutritional sprays containing manganese.

During the month of August, 1944, it was noted that young celery seedlings were not doing well on the seed beds of a commercial grower who had been following the flooding practice described above. These beds had been fertilized according to Experiment Station recommendations and the plants had been sprayed weekly with manganese sulphate. The celery plants generally were showing very poor growth and many of them had died, leaving a poor stand. The remaining plants were yellow and chlorotic and the roots were brown with many lesions. A few isolated spots in the beds were showing slightly better growth, but there were no really normal plants in any of the beds. Fourteen soil samples taken as 1½ inch cores to a depth of 2 inches were collected in pairs from adjacent areas in the beds where the plant growth was classified as (1) "very poor" and (2) "fair." Nitrogen, phosphate and potash tests on these samples showed no differences that correlated

with the differences in plant growth. However, pH determinations furnished a good clue. The seven soil samples classified as supporting "very poor" plants had pH values of 6.55, 6.65, 6.15, 6.85, 6.95, 7.00 and 6.75, averaging 6.70. The seven soil samples taken from adjacent areas classified as supporting "fair" plants had pH values of 6.10, 5.85, 6.20, 6.25, 6.15, 6.40 and 6.60, averaging 6.20. Seed bed areas on the farms of other growers were examined. Some of these showed the same poor condition and had soil pH values well above 6.00. Those showing excellent growth had pH values of 5.60 to 5.80.

In order to check the effect of soil pH on the growth of young celery seedlings, a series of plots was established on newly prepared celery seed beds in the area described above where the fourteen soil samples were taken. The treatments consisted of 0, 10, 20 and 30 pounds of very finely ground agricultural sulfur per 300 linear feet of bed approximately 4½ feet wide. The treatments were replicated three times. The sulfur was broadcast by hand along with a commercial fertilizer and thoroughly worked into the soil to a depth of about three inches. The beds were seeded two days later. Observations made 30 days after seeding showed the plants receiving 30 pounds of sulfur per 300 feet of bed (see Table 1) to be much superior to the other treatments since they were greener and larger in size. By way of contrast, plants on the plots that received no sulfur were yellow and stunted with all the typical symptoms already described. Three independent observers scored all the plots receiving the 30 pounds of sulfur as best and the plots receiving no sulfur as poorest. Plants on the plots treated with 20 pounds of sulfur per 300 feet of bed were fairly good but those on the 10 pound treatment were not much better than the check. These variations between treatments became even more pronounced as the plants grew older. The pH of soil samples collected 60 days after sulfur treatment are recorded in Table 1. The best celery plants were grown where the soil pH averaged 5:60 to 5:90. At a pH of 6.13 the plants were poor and at pH 6.47 they were very poor. When the plants were pulled the first time for transplanting, none were taken from the untreated plots. Stem tissue samples of 60 day old plants were taken for manganese analysis. The average analysis for each treatment is recorded in Table 1. Here it is shown that at pH level 6.47 there was only a trace of manganese in the stem tissues, whereas, at pH levels below 6.00 the uptake of manganese is recorded as quite considerable. Since all

Photographs showing height of celery plants in beds three months after seeding.



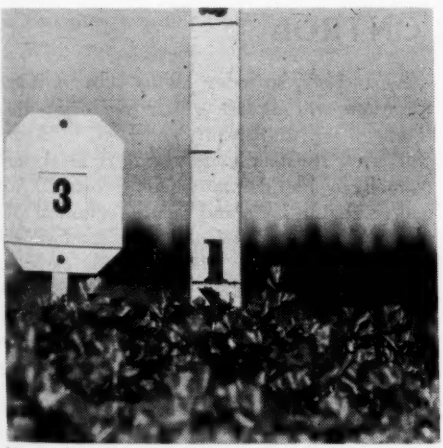
No. 1—No sulfur applied. Soil pH, 6.3

No. 2—Twenty pounds sulfur per 300 feet of bed. Soil pH, 5.7

plots received the same amount of manganese in the fertilizer, the availability of this element is shown to be very appreciably influenced by the soil pH. The unavailability of this element under such conditions was evidently an important factor in the failure of celery seedlings on peaty muck soils with a pH above 6.0.

Since maximum response to sulfur treatments may not have been reached in the experiments just described, a new series of treatments involving a wider range of sulfur applications was laid out in triplicate. Table 2 lists these treatments and their effects upon soil pH and the growth of the celery seedlings. Here again a tremendous response to sulfur was obtained with maximum growth occurring from the 20 to 40 pound treatments which resulted in soil pH values of 5.20 to 5.73. Heavier treatments were found to be detrimental. Photographs of celery seedlings on plots representing treatments 1, 2, and 3 are shown in Plate I. The poor stand and growth of the plants on the soil with the higher pH are evident from these photographs.

At the same time these tests were made, two additional plots were treated with sodium sulfate and calcium sulfate at rates equivalent to 10 and 20 pounds per plot of sulfur respectively. No response to these treatments was obtained. Therefore it would appear that the response to sulfur treatment under these conditions was not due to the sulfur as a nutrient, but to the changes brought about by lowering the soil pH as a result of oxidation of the sulfur by soil micro-organisms.



No. 3—Forty pounds sulfur per 300 feet of bed. Soil pH, 5.2

In the spring following these experiments a cover crop of shallu was planted on a portion of this seed bed area that had never been treated with sulfur. This crop also began to fail. The roots were brown, the leaves were yellow and chlorotic and the plants were dwarfed. One corner of this cover crop area was divided into small plots and sprayed with various nutrients. The plants responded tremendously to manganese sprays. This evidence with the crop shallu indicates that one factor contributing to the failure of celery seedlings on the peat and muck soils with pH values above 6.0 might be a deficiency of manganese.

In the time that has elapsed since these experiments were conducted, pH tests have been made on many seed bed areas. In all cases where sulfur has been recommended, either as a general broadcast application prior to bed preparation or after bedding, the soils have been checked for pH only after allowing reasonable time for the sulfur to act. The growth of the celery seedlings also has been carefully observed. All of these supplemental tests have confirmed the earlier findings and have led to certain recommendations with respect to sulfur treatment for celery seed beds on Everglades Peat, Okeelanta Peaty Muck and Okeechobee Muck Soils. The recommendations are summarized in Table 3. The broadcast application prior to preparation of beds is preferable. This is especially true on the higher pH soils where large amounts of sulfur are necessary. In such cases the sulfur should be applied at least 3 weeks prior to bedding and a pH check made after bedding to ascertain whether or not any final adjustments are necessary before seeding. Inasmuch as areas of extremely high pH have been brought into successful production of celery seedlings this procedure has proved very satis-

factory. After the soil of such an area is once adjusted to the optimum pH level by the over-all broadcast method, a small annual application of sulfur is usually sufficient to maintain the proper pH even where the practice of flooding is employed.

TABLE 1—EFFECT OF SULFUR APPLICATIONS UPON SOIL pH AND ASSIMILATION OF MANGANESE BY CELERY SEEDLINGS

Treatment No.	Sulfur, Lbs. per 300 feet of Bed[1]	Soil pH[2] No. 1	No 2	No. 3	Av.	Mn in Stem Tissue ppm. Oven-Dry Basis
1	0	6.50	6.50	6.40	6.47	Trace
2	10	6.20	6.10	6.10	6.13	4.1
3	20	6.00	5.90	5.80	5.90	9.2
4	30	5.40	5.60	5.80	5.60	8.8

[1]Beds 4½ feet in width.
[2]Glass electrode method. Samples collected 60 days after treatment as 1½ inch cores to a depth of 2 inches.

TABLE 2. EFFECT OF SULFUR APPLICATIONS UPON SOIL pH AND GROWTH OF CELERY SEEDLINGS ON OKEELANTA PEATY MUCK

Treatment No.	Sulfur Lbs. per 300 Feet of Bed[1]	Soil pH[2] No. 1	No. 2	No. 3	Av.	Height of Plants Inches No. 1	No. 2	No 3	Av.
1	0	6.30	6.30	6.40	6.33	4.2	4.1	4.6	4.3
2	20	5.70	5.80	5.70	5.73	8.1	8.0	8.7	8.3
3	40	5.30	5.20	5.10	5.20	9.4	9.0	9.5	9.3
4	60	4.80	4.90	4.90	4.87	7.2	7.4	7.1	7.2
5	80	4.60	4.90	4.60	4.70	5.7	5.5	4.4	5.2

[1]Beds 4½ feet in width.
[2]Glass electrode method. Samples collected 60 days after treatment as 1½ inch cores to a depth of 2 inches.

TABLE 3. SULFUR APPLICATIONS RECOMMENDED FOR CELERY SEED BEDS ON EVERGLADES PEAT AND MUCK SOILS

Soil pH	Lbs. Sulfur[1] per 300 Feet of Prepared Seed Bed 4½ Feet in Width	Broadcast Sulfur Applications[2] (Pounds per Acre)
5.9 to 6.1	10	500
6.2 to 6.3	20	1,000
6.4 to 6.6	30	1,500
6.7 to 7.0	40	2,000
7.1 to 7.4	50	3,000

[1]Very finely ground agricultural sulfur.
[2]Applied prior to preparing beds on field scale.

RECENT ADVANCES IN WATERMELON DISEASE CONTROL

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Laboratory

Leesburg

Two years ago I appeared before this Society and gave a paper entitled "Watermelon Disease Control." Today, I want to bring you up-to-date in our thinking on this subject. Disease control is very dear to the hearts of watermelon and cucumber growers in this, and other states along the Eastern Seaboard. The word "dear" can also connote expense, and at times it applies here.

As in 1947, so today let us start with the Fusarium wilt disease (*Fusarium oxysporum* f. *niveum* (E. F. S.) Sny. and Hans.). There still is no resistant variety that is liked, and planted, by Florida watermelon growers. We had on trial in Lake and Sumter counties, also near Wauchula in 1948, a wilt-resistant variety we call "Ironsides." The variety is early, in contrast to our Blacklee, does not sunburn as much as the Blacklee, is large, of excellent quality, and black-seeded. But it seems prone to hollow-heart. Three growers who tried it in 1949 want it in 1950, despite the hollow-heart they observed. So, it must have some appeal. Other growers will plant 5 or 10 acres

in 1950, and we shall determine accurately its weakness in this regard.

We have grown at Leesburg a number of other wilt-resistant varieties. The Black Kleckley (whose rind is too soft, but is very sweet and does have some resistance to anthracnose), the Miles (also too soft a rind and has too many seeds), the White Hope (another Hawkesbury), the Missouri Queen, and the Dixie Queen, Wilt-Resistant. The last two varieties deserve to be tried in our state. However, let me caution you that there exist strains of Dixie Queen, Wilt-Resistant that show rather low resistance to Fusarium. Apparently, this variety is mixed as far as resistance to wilt is concerned.

In our melting pot at Leesburg we have 5 or 6 unnamed wilt-resistant melons, almost ready for trial by growers, which are promising. Also in the process of development is the long hoped-for wilt-resistant Cannon Ball. This may be ready by 1951 or 1952. My good friend, Dr. C. F. Andrus of the U. S. Regional Breeding Laboratory, Charleston, South Carolina, likewise has several unreleased varieties resistant to wilt. So, look for 4 or 5 new wilt-resistant varieties in the next few years. However, for the time being, growers in Florida must continue to seek new land, or land not in watermelons for at least 8 but better 10 years, on which to plant the Cannon Ball and other wilt-susceptible varieties.

With the release, in September, of the variety Congo by Dr. C. F. Andrus, we have our first commercial variety that is resistant to anthracnose (*Colletotrichum lagenarium* (Pass.) Ell. and Hals.). The Black Kleckley variety possesses resistance to anthracnose to a lesser degree, but its rind is too soft to permit shipping, as I mentioned previously. The Congo is, to all intents and purposes a Garrison. Its longitudinal stripe is darker green however, and its rind is much tougher. Instead of breaking, as does Garrison, the rind on the Congo is likely to bruise. I have heard some complaints against this. We scientists develop a melon that won't break, and then we get complaints because it bruises!

Several melon diseases can be mistaken for anthracnose. Downy mildew, as well as gummy-stem blight look like anthracnose. Therefore, growers must be educated not to expect the Congo to remain free from disease. It will get some anthracnose since it is not immune. But, despite attack, the foliage of the Congo is not easily injured, and the rind possesses high resistance. This variety has only slight resistance to wilt; not enough to chance planting it on infested land. So, its use in Florida will be as limited as is the Cannon Ball, Garrison, etc. Apart from disease considerations, the Congo is a fine melon, and should be tried by growers everywhere.

We advocate pre-planting seed treatment of watermelons, using dry chemicals such as Spergon, Semesan, or Arasan, or the mercuric chloride dip treatment. These treatments eradicate fungus spores on the seed. If the fungus suspected of being present is anthracnose, then eradication seems to be 100 percent effective with a dry or a wet chemical treatment. If gummy-stem blight is the disease, then the dry treatments do not give perfect protection. We believe that the mercuric chloride dip *should* give perfect control of gummy-stem but experimental results are still incomplete.

We believe also that the anthracnose fungus does not live in the soil from season to season in Florida. On the other hand, we know that the gummy-stem fungus does survive. One organism cannot withstand the high soil temperatures of the Florida summer; the other can. During July, August, and September soil temperatures 6 inches deep can go as high as 97° to 105°F. At lesser depths the temperatures are higher. After two seasons of observation it appears that anthracnose does not occur in melon fields planted on the sandy soils of Florida if treated seeds are used. In northern Florida, and in Georgia and South Carolina, the use of treated seed is markedly reducing the occurrence and seriousness of anthracnose. However, we are not so sure that the summer soil temperatures of these northern and heavier soils will kill the anthracnose fungus. Here and there in these areas anthracnose has appeared even though treated

seeds are planted. In Wisconsin and Michigan it has been shown that the anthracnose fungus survives in the soil for at least one season.

Should anthracnose or gummy-stem blight appear in watermelon fields, dusting or spraying will check and keep them under control. In 1947 we recommended the fungicides fermate, dithane, copper-lime, and tribasic copper sulfate. Today, we know that the best control is given by dithane; we go even further and say that dithane Z-78 is better than dithane D-14. Parzate, which is a similar substance to dithane, the two made by competitors, does not give as good control as dithane; and parzate is better than parzate Liquid. Spraying gives better control than dusting, and the addition of a sticker to the spray gives better control than when the sticker is omitted. We know also that the coppers will not control gummy-stem blight as well as will dithane. And, once again the dithane Z-78 is preferred over the dithane D-14.

We have no varieties resistant to gummy-stem blight (*Mycosphaerella melonis* (Pass.) Chiu and J. C. Walker), and no breeding material which possesses this desirable character. With the proven value of seed treatment, and availability of the Congo variety, plus the belief that the anthracnose fungus does not persist from season to season in the sandy soils of Florida, it follows that anthracnose is no longer much of a threat to Florida melon growers. Gummy-stem blight persists, however, as a distinct threat. The mercuric chloride seed dip may reduce much potential danger from this source.

The last disease we consider is indeed a worthy foe. Downy mildew, caused by the fungus *Peronoplasmopara cubenis* (B. and C.) Rostow, today stands at the head of the list of dangerous fungi that attack watermelons and cucumbers. We cannot treat seeds to control mildew, for it comes from south Florida, borne as spores by the winds. The Palmetto cucumber variety is highly resistant. But we have no resistant melon varieties, though at Leesburg we have primitive melons that carry some resistance. Therefore, the melon grower must apply prophylactic or preventative measures, to-wit, spraying or dusting with a fungicide. Be the grower in Florida or in northern states, fungicide usage becomes almost imperative year after year. By breeding, slow at the best, we hope to incorporate resistance to mildew with other melon qualities.

Research at Leesburg, confirming what has been found simultaneously elsewhere, has shown that the best fungicide to use in the control of downy mildew is tribasic copper sulfate, closely followed by zerlate. Dithane does not do as good a job against mildew as it does against anthracnose, but it will satisfy the most exacting grower. From one season's experience we find that zerlate seems to encourage the multiplication of aphids or plant lice. Therefore, we hesitate to recommend it for melons in Florida.

We mentioned in 1947 that a disease forecasting service for watermelon growers was worthy of consideration. Such a service would tell growers what diseases threatened their crop, and whether application of a fungicide was advised. The idea was not only to save melon foliage and fruits by fungicide applications, but save money by not applying any chemical prophylactic when not needed. Since then, no concrete action has been taken by Florida growers. But South Carolina in 1948, and Georgia in 1949, sent extension agents to Leesburg, to be trained in melon disease identification. These enlightened men report encouraging progress, namely, less disease in their counties because of proper timing of applications of the best fungicide. Growers like the new service, which will be continued indefinitely.

This May there was released a revision of Walker and Weber's bulletin "Diseases of Watermelons in Florida." Most of what I have discussed here today is included in Bulletin 459 of the Florida Agricultural Experiment Station.

WHAT'S NEW IN TRUCK CROP MACHINERY AND WHAT MORE DO WE NEED?

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What's new in farm implements and field methods used in Florida for the production and harvesting of truck crops, is largely determined by the point of view and the experience of each individual.

The potential crop diversity of Florida agriculture has provided ample justification for the farmers to try out virtually every type of equipment that has been manufactured by the farm equipment and tractor industry. Even with the rapid transition to tractor farming that has taken place during the past few years many farmers continue to use one-mule-equipment, typical of the units of the old Southland.

Florida, in many respects, is still a pioneer state with extensive areas of undeveloped land and with many important problems still unsolved in the field of farm management and marketing. This state offers fascinating opportunities for the commercial adaptation of many tropical crops, the winter production of the numerous truck crops, and the usual growing season for all vegetable and farm crops common to the Southeastern states. To offset these opportunities Florida is somewhat handicapped with certain climatic hazards and intensity of crop pests that would be quite unusual in other states.

Vegetable production in some areas of Florida represents extensive, and, at the same time, highly specialized phases of agriculture. The income from these operations and the physical factors associated with the land have justified the local development of virtually tailor-made machines which have limited and specific applications. Such farm equipment developments, combined with certain crop production programs, frequently cause some of our out of state visitors to question the old adage "that there is nothing new under the sun."

Without doubt the limitations of the past century in terms of horse-drawn equipment, in good part, hold the key to the fact that the early pioneers largely by-passed the State of Florida. When the agricultural history of Florida is written it will probably be made clear that the modern, internal combustion engine has been the greatest single factor in the rapid agricultural development in Florida that has followed.

There is considerable room for argument with respect to which tools or implements should be placed second in importance to this development. Doubtless this honor should go to the gas cutting torch and to the electrical arc welder. These units have become so common-place that many farmers are highly skilled in their operation.

The Florida farmer, by necessity, is an inventor and a mechanic of sorts. Very few of the nationally available agricultural implements can be used directly under some of Florida's special soil and crop conditions. In true fairness to the national farm tractor and implement industry, many of the special developments in Florida equipment are strictly cooperative projects. A farmer having a special farm problem, has one basic objective, "to get the job done." For this purpose he will borrow a few ideas, if necessary, make major modifications of a standard implement, and then perhaps add attachments made up of parts obtained from many different manufactured items.

Farm implements having a too localized application cannot attract the interest of a large manufacturer who specializes in assembly line production of a standard line of implements. Insofar as the agricultural economy of the state is concerned, there is an actual need for many specialized units of farm equipment which can only be the product of local machine shops or of the farm shop.

Efficient farm implements which have been developed as a community project or as the results of one man's effort, are often passed along to other farmers with no desire for compensation. An accurate record of the development of this phase of Florida agriculture certainly will have to give credit to many individuals who through their patient and sincere efforts have worked out efficient and economical machinery and systems of crop production and harvesting. Even though there have been some costly failures, the experience gained may have been a direct aid, in many instances, to the solution of another problem. It is apparent that the normal, free-will exchange between farmers could be made more effective if true specifications of the machines or ideas were clearly set forth in accurate, engineering drawings. Then the progress would be more direct and rapid because actual costs as well as time and other losses would be reduced.

Eighty-one pictures covering new equipment and methods used in truck crop production and harvesting in Florida were projected during the oral presentation of this paper. Even with this large number of pictures it was necessary to omit several interesting machines or methods, and to select one picture out of several that represented direct, competitive units. Due to space limitations for this published report, equal fairness can not be given to all new machines, hence, all are omitted.

"What's needed in truck crop equipment" represents a subject that could be expanded into almost unlimited detail. Farmers from area to area would question the relative importance and needs for suggested new implements, modifications, and/or methods. Some desires for serviceable equipment may become an early reality through the selection and modification of existing machines or experimental units. Other needs and problems will border on the field of the unknown where any equipment presently available does not promise a solution and essentially new designs become a necessity.

Some implement needs are so definite and basic that many men are greatly concerned. Each, in his own way, is spurred on by the highly important overall objective, a low unit cost of production and harvest of farm products of high values. A farmer, or a member of the implement industry, will have his individual ideas in the development of a new agricultural implement or a procedure for its use. With no thought of discrediting the many different individual methods whatsoever, consideration should also be given to a local procedure that may be followed under an approved project of an Agricultural Experiment Station.

Definite farm machinery needs are generally rather complex because they involve the application of basic engineering principles to some physical, chemical or biological problems. Only highly-trained subject matter specialists in the overlapping subject matter fields involved, are best prepared to determine the basic, fundamental requirements of the needed mechanical procedures.

Research men in the biological sciences can seldom translate their highly technical requirements into definite machine functional designs and into an efficient machine and field practice. This requirement provides justification for a somewhat hyphenated profession known as agricultural engineering.

Careful economic studies of crop production and harvesting, call them "POST MORTEMS," if you please, show that labor and power costs represent a very high percentage of the total costs. Farm profits and losses are generally expressed on the basis of the acre unit, and percentage returns on the capital investment. An ideal Florida farm is a self contained unit having as its principal long-time objectives, soil fertility building, economical crop and livestock production, and a net income capable of meeting all the needs of the farm family. The yearly average net return per man hour of work is a basic and a true common denominator for the comparison of different agricultural crop production programs or systems of agriculture. Under such a system of valuations, labor saving machinery will show high rates of labor income. The farmer is like the factory worker, he wants to

know the amount of his "take-home" pay.

Comparatively little effort, state or federal, has been given to a careful study of the effect of proper implements design and functioning in the reduction of crop costs. The true value of an agricultural implement cannot be figured by empirical engineering or mathematical formula. Only careful, comparative field testing of equipment and of methods of use can provide the relative measurement of the growth responses of a crop on a given soil type within a given season.

Thus coordinated studies of soil, tilth, and other problems in other states have provided substantial evidence that the proper use of certain equipment will so increase crop yields and improve their quality that added farm profits will follow.

By way of summary, some details of equipment needs can be satisfied by critical adjustment, by the modification of existing machines, or by the clever use of available attachments. The solution of these relatively simple problems are largely a matter of experience and personal skill and have long since become the normal duties of the farm equipment dealer, as well as the farmer himself under Florida conditions.

However many machinery needs and problems still border on the field of the unknown. Here is found, first of all, the necessity of establishing certain basic design relationships between the functional requirements of the machine and the certain highly specialized techniques that it must perform on the crop or something associated with the crop. Suitable forms of investigation or inquiry must then be set up to obtain the needed data on the unknown factors. The development of the subject at this point is too complex to attempt to explain in a space so brief the engineering processes that might be required to modify or to design and develop such a machine as might be outlined in a general way by a subject matter specialist.

The Agricultural Engineer should have definite responsibility in the following fields of truck crop research: soil tillage, water control and utilization, fertilization, planting, cultivation and chemical weed control, harvesting, crop processing and storage. In addition the engineer has obligations in the fields of economics with respect to labor and power efficiencies and the ability to properly "time" operations through adequate studies of capacity and adaptability of equipment as well as methods.

CONSUMER PACKAGING ON FLORIDA BEANS

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One of Florida's largest industries is the growing and shipping of green beans. Last year green beans were 9th in the gross sales of all Florida's agricultural products. For the last 15 years there has been around 75,000 acres of beans harvested per year. The acreage and production is increasing year by year.

Last season, 1948-49, Florida's bean volume was 7,819,000 bushels, 6,819,100 being sold and utilized fresh and 1,000,000 bushels being sold for processing. The packed value for the fresh bean sale was $16,365,600 while those processed brought $1,800,000. The total bean value was $18,165,000. Only one other vegetable grown in Florida brought more revenue into the State than green beans and that was the tomato, with a value of $27,653,500.

Green beans can be grown in Florida economically enough to compete with beans grown in other areas for freezing, canning and consumer packaging. Many beans are transported in bulk to all parts of the eastern seacoast where they are processed—either consumer packaged, frozen or canned. Very few beans are processed in Florida. About 1/10th of the beans grown here are processed either here or in other states leaving 9/10ths sold in the fresh state.

Even if only a small percentage of the beans were packaged at the point of production—enough to supply the retail home stores—this would be a very large industry for Florida. Since the field does have such bright possibilities, and the shippers are somewhat displeased with the present manner of handling and shipping, this investigation was undertaken to find if it would be possible to kitchen prepare and consumer package green beans at the various places of production in Florida.

Conditions of the Experiment

Green beans were obtained from the Pompano area, the same day they were picked, where they were grown and field graded. U. S. 1 grade was used entirely and the beans were snipped and cut, dipped and packaged by hand in the Tropical Plant and Food Research Laboratories of the University of Miami. Several varieties were used, Tendergreen, Black Valentine, Plentiful and Kentucky Wonder. The figures given in the tables and discussion are taken from those of the Tendergreen Variety. No longer than 24 hours elapsed between picking and packaging. The beans were packaged in bags of various materials or in overwrapped trays, using various wrapping materials. These were either in 12 ounce, 1, 2, 4, 8 or 16 pound bags. The beans were placed in overall ventilated cartons where from 2 to 36 packages were packaged. These were immediately placed in refrigeration at 35°, 40°, 45°, 54°F. and room temperature where they remained throughout the experiment. The beans were weighed and observed every 2 days.

Seven different kinds of film were used both as bags and as overwraps on trays. These are listed in Table I. The beans were snipped with stainless steel knives and when cut, were cut into lengths averaging 1½ inches. Control lots were placed on trays in weighed amounts in piles. The beans were washed and dipped in various concentrations of chlorine and citric acid. Those sent out as trial packages were dipped for 5 minutes in solutions of 1050 parts per million of chlorine or a 2% hypochlorite solution containing 5.25% clorine and 1% citric acid. During the first part of the experimentation, the beans were fan dried after dipping, but later on it was found that the beans could be packaged wet without any bad effects. Most of the films used were moistureproof and allowed for considerable amount of condensation on the inside of the bag. While this was not desirable because it detracted from appearance it seems to have no ill effects when the bags are refrigerated 40° F. or below.

Weight Comparisons of Beans in Hampers and in Packaged Cartons

Hampers of beans were weighed (their average being around 30 pounds) as they were packed and graded in the field. The beans were culled and snipped only using the very best. The loss in weight due to snipping and culling of the U. S. 1 grade field graded beans averaged around 20%. From a hamper of beans, 24 packed one pound or 32 twelve ounce packages of kitchen prepared beans were obtained. This means that a saving of 20% is saved in freight by packaging in this manner and the volume cut down considerably. This also set up an even higher quality of bean in that any undesirable beans were discarded.

Loss in Weight of Beans Held at Room Tewperature and 45° F Storage in Various Packages

Table I is a tabulation of the loss in weight of Tendergreen beans packaged in bags of various materials. The bags were not heat sealed but stapled after the top had been turned over twice and a paper tab placed over the top. The figures show that much benefit is derived by most of the bags in that very little moisture is lost and the beans are still fresh after 8 days. Pliofilm 75 FF film gave the best results as far as preventing moisture loss was concerned. All of the films gave some protection against moisture loss, the cellulose acetate (Lumarith) giving the least protection. After 6 days, the beans in this film had lost 25% of their weight. In all cases there was more moisture lost from the snipped and cut beans than those that were only snipped on the ends. The beans not wrapped

lost between 38 to 47% moisture in 6 days. This gives some idea of the enormous loss in weight of beans retailed in this manner without refrigeration. The sale life of the bean was very short when no refrigeration was used, showing the necessity of refrigeration in the commercial handling of green beans. Compare the figures of loss in weight of Table I with those of Table II, which gives the loss in weight of the beans at 45°F. Here the loss in weight is negligible even after 14 days in the Pliofilm, Cellophane MSAT, Cellophane LSAT, Sylphwrap and Vinylite films. The loss in weight again was heavy in the Lumarith, Cellophane No. 146, and in the control where no wrap was used.

Control of Discoloration of Cut Surface and Decay

The retarding of the darkening or discoloration of the cut surface is the most important factor in keeping good quality in consumer packaged green beans. Very soon after the bean is snipped and cut, the area exposed to the air discolors and turns dark at room temperatures making an unsightly appearance.

Table III is a tabulation of the results obtained by dipping Tendergreen beans in a chlorine and citric acid dip for 5 minutes. After drying the beans were weighed in 16 ounce amounts and placed in bags of MSAT 300-86. The bags were stapled and placed on shelves at room temperature and at 45°F. Every 2 days the beans were examined for discoloration and decay. In addition to the temperatures shown on the table, the beans were kept at 35°, 40° and 54° F. It was found that discoloration and decay were directly proportional to the temperature—the higher the storage temperature the more discoloration and decay. The snipped beans kept at 35° and 40° F remained fresh without discoloration of the cut surface for 2 weeks while those held above 40° F discolored much more rapidly than those below 40° F. Those held at 70°—80° F darkened sometimes within 48 hours. More discoloration was obtained in those not dipped than those dipped in chlorine solution, but all indications were that refrigeration was the big factor in reducing discoloration of the cut surface of the bean. The cut surface discolored much more rapidly when the cut was made through a seed or the fleshy part of the bean than when the ends only were cut. It was much more difficult to keep the snipped and cut beans from discoloring than those just snipped. The citric acid was the ingredient in the dip most effective on the control of discoloration of the cut and snipped bean. When larger amounts were used, better control was obtained but not in proportion to the increase in amounts. One very important effect of the citric acid addition was the crispness or hardening effect it caused in the bean. Even when slightly wilted beans were used, a snap or crispness was obtained by dipping in a weak solution of citric acid. Ascorbic acid was used in place of the citric acid and was just as effective in decreasing discoloration but did not give the hardening effect or snap to the bean as did the citric acid.

Decay was not important in those beans held at 35°F, 40°F and 45°F, but was a big factor in those held higher as decay was obtained after 4 days at room temperature in some cases. An attempt was made to decrease the amount of decay at all temperatures by pretreating the beans with various percentages of chlorine solutions just before packaging. Table III shows that there is a direct relation to the control of decay and the concentration of chlorine used in the pre-packaging dip. A 2% hypochlorite dip gave good results. Higher concentrations gave better decay control but gave an odor which was objectionable. This odor disappeared however after the beans were packaged several days. Taste tests made on the cooked bean proved that there were no off flavors derived from the chlorine dip, even those of 5 and 10% hypochlorite dips. The chlorine is very volatile and will volatilize off during the heat of cooking.

Variety Tests

Tests were made on various varieties of green beans—Tendergreen, Black Valentine, Plentiful and Kentucky Wonder. All of the varieties reacted well to consumer packaging. There was very little difference in discoloration or decay between the varieties. The pole

TABLE I. LOSS OF WEIGHT OF TENDERGREEN BEANS CONSUMER PACKAGE IN VARIOUS FILMS (BAGS) AND HELD AT ROOM TEMPERATURE (70-80°F)

Kind of Wrapping Material	Type Preparation	Percent Loss in Weight After 2 Days	4 Days	6 Days
Cellulose Acetate (Lumarith)	Snipped	3.69	12.26	24.53
	Snipped & cut	3.60	12.40	26.74
Sylvania Cellophane PMB 6 CSX-300	Snipped	0.67	3.97	9.13
	Snipped & cut	0.70	4.05	9.25
Cellophane Dupont No. 146	Snipped	3.15	11.21	22.49
	Snipped & cut	3.15	11.54	23.25
Pliofilm 75FF	Snipped	0.25	1.20	2.60
	Snipped & cut	0.26	1.37	3.70
Cellophane LSAT (Dupont)	Snipped	0 21	1.47	3.72
	Snipped & cut	0.24	1.62	4.08
Vinylite P9V20	Snipped	1.43	4.53	8.74
	Snipped & cut	1.10	3.86	8.02
Cellophane MSAT	Snipped	0.36	1.70	3.80
	Snipped & cut	0.31	1.76	4.20
Control (check) No wrap	Snipped	3 35	21.84	38.77
	Snipped & cut	3.15	25.69	47.73

beans were slightly more difficult to package due to their length. There was an interesting preference for different varieties in different sections of the U. S. Some sections preferred the flat bean to the round bean and vice versa. Some sections of the country prefer the pole bean to the bush bean.

Precooling and Refrigeration

Precooling tests were made by dipping the beans in ice water before packaging. It was found that the beans could be very readily brought down to 32-35°F. However, during the time of prepackaging all the advantages of precooling were lost as the temperatures would rise to near that of room temperatures during the subsequent time of handling and packaging. It was found that satisfactory results could be obtained if the packaged beans were placed at around 34°F immediately after packaging. This was true when well ventilated over cartons were used as the packaging and shipping cartons.

During the first part of the experimentation the beans were dried after dipping before placing in the packages. No detrimental effects were noted in the refrigerated beans when this procedure was omitted, but those held at room temperature held up better when the beans were fan dried before packaging. Much better results were obtained in both retarding decay and discoloration when packaging was done directly after the beans were dipped than when the beans were run through a wash water.

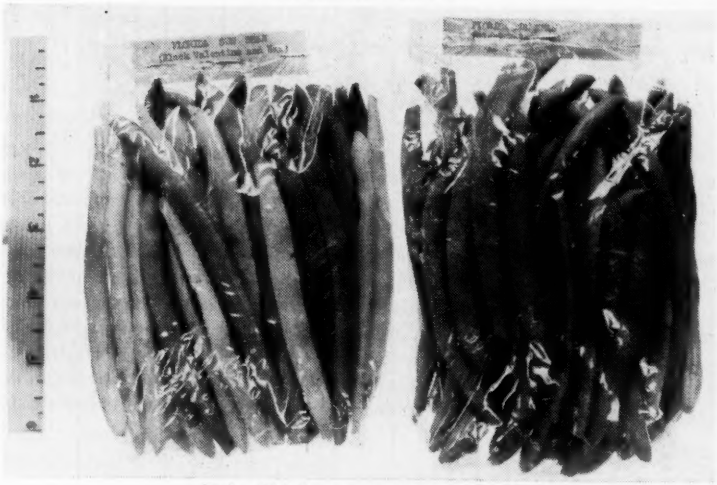
Packaging Material and Consumer Package

Outside of the excessive drying out and loss in weight in the non-moisture proof wrappers there was not much difference in the keeping quality of the beans in various wrapping materials tested. The decay was heaviest

TABLE II. LOSS OF WEIGHT OF TENDERGREEN BEANS CONSUMER PACKAGED IN VARIOUS FILMS (BAGS) AND HELD AT 45°F.

Kind of Wrapping Material (Bags)	Type Preparation	Percent Loss in Weight After 2 days	4 Days	6 Days	8 Days	14 Days
Cellulose Acetate (Lumarith)	Snipped	1.77	4.31	7.90	10.45	19.08
	Snipped & cut	1.80	4.78	8.80	11.74	21.20
Sylvania Cellophane PMB 6 CSX-300	Snipped	0.22	0.84	1.77	2.59	4.79
	Snipped & cut	0.17	0.86	1.81	2.60	5.14
Cellophane Film No. 146	Snipped	1.11	2.70	5.10	6.98	12.94
	Snipped & cut	0.94	3.16	5.74	7.61	15.09
Pliofilm 75 FF	Snipped	0.04	0.25	0.58	0.75	1.40
	Snipped & cut	0.05	0.23	0.56	0.68	1.24
Cellophane LSAT	Snipped	0.05	0.19	0.62	1.01	2.23
	Snipped & cut	0.02	0.17	0.67	1.12	2.57
Vinylite P9V20	Snipped	0.30	0.91	1.68	2.29	4.35
	Snipped & cut	0.23	0.94	1.69	2.30	4.07
Cellophane MSAT	Snipped	0.14	0.50	1.05	1.63	3.20
	Snipped & cut	0.09	0.43	1.05	1.69	3.25
Control (check) no wrap	Snipped	1.84	8 41	17.22	22.93	39.25
	Snipped & cut	0.90	8.92	17.40	24.70	43.80

HOUSEHOLD SIZE



Pack of kitchen prepared green beans
(after 3½ weeks storage at 40° F in 300 MSAT Cellophane)

INSTITUTIONAL SIZE

Pack of kitchen prepared green beans
(after 13 days storage at 40° F in MSAT Cellophane)

in the beans wrapped in the moistureproof films where the humidity was very high within the package. This humidity seemed not to make any difference when refrigeration of 45°F or below was used. The discoloration was no heavier in the high humidity bags than those where no moisture accumulated. Bags and overwraps of the various materials were

TABLE III. EFFECT OF CHLORINE AND CITRIC ACID DIP (5 MIN) ON DISCOLORATION AND DECAY ON PREPACKAGE SNIPPED TENDERGREEN BEANS, IN MSAT 300 GA BAGS AT R.T. 70-80°F AND 45°F.

% Hypochlorite Solution	ppm Chlorine	% Citric Acid	Storage Temp.	Discoloration of cut Surface after 2 days	4 days	6 days	8 days	14 days	Percent Decay after 2 days	4 days	6 days	8 days	14 days
0.0	0	0	R.T.	—	+—	++	++	++	—	+—	+—	+	++
			45°F	—	—	+—	+—	+	—	—	—	—	—
0.0	0	1.0	R.T.	—	—	+—	+—	+	—	+—	+—	+	++
			45°F	—	—	—	—	—	—	—	—	—	—
2.0	1050	0	R.T.	—	+—	+—	+—	+	—	—	+—	+	++
			45°F	—	—	—	—	+—	—	—	—	—	—
1.0	525	1.0	R.T.	—	—	+—	+—	+	—	+—	+—	+—	+
			45°F	—	—	—	—	+—	—	—	—	—	—
1.5	788	1.0	R.T.	—	—	—	+—	+	—	+—	+—	+—	++
			45°F	—	—	—	—	+—	—	—	+—	—	—
2.0	1050	1.0	R.T.	—	—	—	+—	+	—	—	—	+—	+
			45°F	—	—	—	—	+—	—	—	—	—	—
2.5	1313	1.0	R.T.	—	—	—	+—	+	—	—	—	—	—
			45°F	—	—	—	—	+—	—	—	—	—	—
5.0	2625	1.0	R.T.	—	—	—	+—	+	—	—	—	—	—
			45°F	—	—	—	—	—	—	—	—	—	—
10.0	5250	1.0	R.T.	—	—	—	+—	+	—	—	—	—	+—
			45°F	—	—	—	—	—	—	—	—	—	—

Relative degrees of Discoloration and Decay: — none, +— slight, + medium, ++ severe.

perforated with several holes (1/32nd inches in diameter) and beans packaged in these compared to some packaged with no perforations. Very little difference was observed, especially in those refrigerated. Those held at room temperature kept best in perforated bags and overwraps.

Bags of beans of the various materials were heatsealed and compared to those where the tops were turned over twice and stapled. No difference was found in the keeping quality of the beans refrigerated but those at the higher temperatures showed package bloating, due to excessive respiration in the heatsealed bags, while this did not occur in the stapled bags where the pressure was released by the CO_2 escaping through the folded flap.

Beans in bags were compared to the same variety in trays overwrapped with the same wrapping material. In all cases the ones in bags were marketable slightly longer than those in trays. The beans next to the tray showed more discoloration and decay than those directly under the film. Waxed trays gave better results than unwaxed trays.

Over-all Shipping Cartons

Several types of over-all shipping cartons were tried among which were the paper board carton both ventilated and unventilated; the wooden lug similar to the avocado lug; and the paper board display carton used in fancy packing where the material is sold from the carton and the advertising is printed on the uplifted lid. The most economical and practical one was found to be the ventilated paper board carton, having square or almost square dimensions. Best results were obtained in those paperboard cartons which had ventilation on all six sides. Cartons which were ventilated by slits, when the slits extended the entire height of the box, were found to give better results than those ventilated by round or oblong holes here and there. The beans were packed in the cartons using 12, 18, 24, and 36 bags to the carton. The cartons holding the smaller number of bags gave slightly better results but the difference was not enough to warrant the difference in cost of packaging. It was more economical to package 24 and 36 bags or trays to the carton and the nearer the carton was to being square the more economical was the cost of overall packaging.

Large institutional size bags were used to package Tendergreen beans. Bags holding 2, 4, 8, and 16 pounds were used and these placed in ventilated over cartons—(12–2 pound, 8–4 pound, 4–8 pound and 2–16 pound). It was found that these large amounts of snipped beans can be consumer packaged, resulting in good keeping quality for 2 weeks when refrigerated at 40°F, dipped in chlorine–citric acid solution for five minutes, and packaged in moistureproof bags. Snipped and cut beans could be kept in good quality for one week, slight discoloration of the cut surface occurring after this time.

Commercial Trial Shipments

Using the information gained in the laboratory experimentation beans were packaged in commercial cartons containing 12, 18, 24, and 36 bags or trays and sent to 10 different places in the United States. These were New York, Philadelphia, Boston, Cleveland, Pittsburgh, Atlanta, Memphis, Kansas City, San Francisco and Dallas. The size of the shipments were from 3 to 6 cartons at one time. Some were sent by air, some by refrigerated truck and most by refrigerated rail car. They were sent to large fruit and vegetable produce buyers who entered some into the regular channels of retail trade and some were observed under various conditions by experienced vegetable men.

The temperature recommended to the truck and rail lines was 40°F and efforts were made to maintain this throughout. After leaving the rail car or truck, most of the cartons were placed in refrigeration at 40°F or placed in the refrigerated show case. Those sent by plane were not refrigerated en route but were held under refrigeration thereafter.

In every case enthusiastic reports were received giving the reaction of the wholesale buyer and retail buyer in some cases. Those packages placed in the retail store in competition to bulk beans sold rapidly and much faster than bulk beans even though there was a mark-up in price of several cents

on the packaged beans. When the beans in cellophane bags were offered for sale in competition to beans of the same variety in cellophane or pliofilm overwrapped trays, and of the same weight, the beans in bags were preferred and sold 2 to 1.

Whenever both 12 ounce and 16 ounce bags and trays were shipped the preference was always for the 12 ounce lot. The 12 ounce package was equivalent to 1 pound of bulk beans in finished ready to eat product. It could be placed beside the bulk bean and sold for the same price as the one pound bulk. If one pound kitchen prepared packages were used, a few cents markup over the bulk bean was necessary. The 12 ounce bag outsold everything else.

Every time a number of cartons were sent out into commercial channels control samples were kept in the laboratory and placed under conditions duplicating those of the commercial handling. The results obtained at home were comparable to those reported from the commercial channel. Those packages that were held at home at 40°F or below and had been dipped in the chlorine-citric acid dip before placing in the moistureproof wrappers held in good marketable condition for 2 weeks.

In one case in New York City half were kept at room temperature and the other half in refrigeration. Discoloration of the cut surfaces were observed after 2 days from refrigeration while those held at 40°F were still marketable after 14 days.

The investigation has shown that green beans can be successfully consumer packaged, resulting in good quality Florida beans being offered the consumer. Consumer packaged beans were received in satisfactory condition in distant markets and remained marketable there for a sufficient length of time on the retail stand to be profitable. We are planning on continuing this research this season in carrying it one step further into a pilot plant set-up where a real commercial test will be obtained.

We wish to thank Mrs. Herbert Clark of Pompano, Florida for her aid in the distribution and commercial handling of the beans as well as supplying the beans for these experiments.

GROWER'S RELATION WITH THE PRESS

Nixon Smiley

Agricultural Editor, Miami Herald

Miami

Last year I covered the annual meeting of the Florida State Horticultural Society for the first time.

A puzzling thing about that meeting to me was an absence of any plan to help the press to get information. I had no trouble in finding out who the officials were, and the program gave me the names of the speakers and the titles of their subjects. But getting a good advance story about the meeting was a hard job. No plan had been made to help the press to get the kind of information that was needed to make a good, readable story.

And when the meeting got underway there were times when the society's four sections were all meeting in separate places at the same time. It was impossible to cover all of them. As some of the speakers didn't turn in their papers at once, I found it impossible to get information that I sought. One well-meaning official told me not to worry; that all papers delivered at the three-day meeting would be published "in a few months," and I could get what I needed then.

The grower's apathy toward what is sometimes called "press relations," or "public relations" is not altogether his fault. Until the last few years the newspapers have made little fuss over the farmer. The farmer got into the paper when his cow gave birth to a two-headed calf; when drought threatened the corn crop; when the price of potatoes brought complaints from the editor's wife.

The New Deal changed all that. The farmer, and Mr. Wallace, you may remember, made

the front page of your newspaper just about every day for quite a spell back in the middle thirties. Wallace got off the front page—and finally out of the paper—but the farmer has remained in the spotlight. He's likely to stay there for some time to come.

With high food costs and government price supports, the farmer, and farm products, have become as newsworthy as politics, crime and sex. The newspapers haven't had anything to do with this trend. It's the editor's job to carry the news as he sees it.

People have to eat, and when eating costs people a lot of money they get mighty interested in who gets the money they pay for food. Any story which deals with food rates high in present-day readability tests. Even a story dealing with such complicated things as the government's problems in establishing parity prices for corn or potatoes will get a going-over by the majority of readers, even when most of them can't understand much about it. They'll try to read the story because, when Uncle Sam starts tinkering with this parity thing, Mr. Consumer figures he might have to dig a bit deeper into his pocket.

In this day when so many minorities are trying to get their own "story" told, with the purpose of winning approval from the majority, the farmer has been satisfied to plow his own row. Although most growers probably haven't thought much about it, the farmer has to class himself as a "minority." As science and machinery continue to help increase the yield of food per acre, yet reduce the number of laborers on the farm, the grower's role as a member of a minority group will mount in importance.

Right now the farmer is riding pretty high in a political sense. As a matter of fact, he is one of the strongest minorities in the country, from the political standpoint. But among labor and the white collar groups there is strong feeling today against the government's price support program. Whether it's right or whether it's wrong, these people don't like it.

"One of these days," some of these fellows are saying, "we'll kick the rascals out of Washington. And when we do, this foolishness about price supports will come to an end."

It seems to me that it's about time for the farmer to become public relations minded. A lot of growers have admitted, among themselves, that the price support program has become a political tool. They can see that there will be a day of reckoning. The Farm Bureau, National Grange and other farm organizations have blasted many parts of the government's program.

But the farmer, as an individual or as a group, is doing very little today to acquaint the public with his problems or his viewpoint. The national farm organizations have fallen down in the public relations field. The public classifies most of them as lobbies, and these organizations have done little to change the public's attitude.

Now what is the attitude of the newspapers about the farmer? I'm not referring to the editorial page. The stuff you read on the editorial page represents the opinion of the editor. I'm referring to the attitude of the newspaper reporters and editors who handle the stories that you read in your daily papers.

The average reporter is a college man. He has spent most of his life in school or working for a newspaper. He knows very little about farming or about farmers. He could tell corn from oats and beans from potatoes, if he saw them growing in the field. But he's probably never walked behind a plow, driven a tractor or hoed cotton. He would know which end of a cow to milk, but there his knowledge would end. He wouldn't have much idea about the cost relationships between feed and the price of milk. A farmer to him is an overalled fellow who usually sports a three-day growth of beard and quit school in the fourth grade.

But whatever the reporter's picture of the farmer, he's usually pretty well trained in his field. If he has the facts, he can write a story about the farmer, or about his activities, and he can do a good job of it. If he can get the facts about the relationship of feed costs and the price of milk, he can take these facts and write a story that the public will be able to understand. And it's not unlikely that a great

many will read the story and think, "This writer must have been raised on a farm."

I believe one of the great needs of the Florida State Horticultural Society is a press representative, or public relations man. He should be appointed by the president. He would work closely with the executive committee and it would be his job to keep the name of the Society and its activities before the public.

I don't mean that he should be strictly a "promotion" man. We've already got too many promoters in this country. But you should have someone who has a wide acquaintance among farmers and our agricultural scientists, who could help reporters in their coverage of these annual meetings.

Persons invited to speak before the society should be asked to prepare an extra copy of their talk so that it could be placed in the hands of your public relations man. It's impossible for a reporter to attend all four section meetings at the same time. And yet there are many interesting papers read before all of these groups. If this extra copy of the various papers was kept at the registration desk, any member who missed hearing them could check them for information. I know that the chairman of each section receives a copy of papers for publication in the proceedings, but it's usually hard for a reporter, or one of the society's members, to corner a chairman long enough to check through these papers.

Not only does the reporter need to see these papers to get information for spot stories about the meeting, but also for the possibility of writing good features for later publication. I know that, when I saw the proceedings of last year's meeting, I was surprised that I had missed so many good story possibilities. But the material was then so old that I hesitated to use it in a daily newspaper.

These proceedings are of vital interest to the people of Florida, not only to the farmer or grove owner, but also to the home gardener. An effort to make this information immediately available for publication after the papers have been delivered would add greatly to the Horticultural Society's prestige. In Florida, especially, there is very strong interest in horticultural subjects. Every home owner who has a few citrus trees or a vegetable patch identifies himself with the farmer. He invites his friends over to see his "farm."

Because the grower and the things he produces rate high in readability, the farmer should take advantage of this. Farm organizations, and societies such as this one, should do all they can to build good will. There's no better way to do this than through the press.

PROCESSING SECTION

A TWO-YEAR SURVEY OF FLORIDA COLDPRESSED OIL OF ORANGE

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Lake Alfred

This report covers a two year survey on Florida citrus oils[1 2]. However, other factors in addition to those previously reported have also been investigated and are presented. A comparison of the properties of oils studied during the 1947-48 season is made with those of the 1948-49 season.

The principal purpose of this study was to determine by what means oil of orange of very high quality could be produced. Another purpose was to determine the relationship between the physical and chemical characteristics of oil of orange and such factors as seasonal variation, methods of extraction and methods of processing.

Through the use of the data obtained, it is hoped that the citrus industry in Florida will be able to produce citrus oils which will consistently meet the specifications of the United States Pharmacopoeia[3] and also other high quality requirements of essential oil consumers. The production of oils of highest quality and uniformity should result in a larger consumer market.

The methods of commercial manufacture, survey of commercial plants, collection of samples and the physical and chemical methods of analyses have been discussed in a previous report[2] and were the same for both the 1947-48 and 1948-49 seasons.

Experimental Results

Data secured at the various processing plants pertaining to the yields of oil obtained by the different methods of extraction were averaged and are presented in Table 1. This table also shows the relationship between the yields of coldpressed oils of orange which were obtained by the four methods of extraction and the physical and chemical properties of the oils, with the exception of aldeyhde content. Data for all four of the different methods of extraction were not available for the months prior to February; therefore, they could not be used to secure average values for purposes of comparison. These data represent average values for the months of March, April and May, during which time most of the oranges processed were Valencia. Samples of oil were taken once a month from lots of oil ranging from 500 to 11,000 pounds, which represented the production for approximately one week.

The aldehyde content of expressed oil of orange can be seen in Table 2. Here, also, the average values for the aldehyde content of samples of oil secured during March, April and May are used.

Discussion of Results

Relation of Yield to Properties of U. S. P. Specifications.—The factor which was found to influence the physical and chemical properties of coldpressed orange oil to the greatest extent was the yield of oil secured from the peel. As shown in Table 1, except for some variations in the case of the Pipkin roll, as the yield increased the values of specific gravity, evaporation residue, and refractive index also increased, but the values of optical rotation decreased. Thus, the percentage of the total amount of oil in the peel that is extracted determines the characteristics of the oil, and, therefore, its final quality. As the yield of oil is increased more high-boiling, high-molecular weight constituents are evidently extracted and the presence of a greater percentage of these compounds in the oil causes a reduction in the percentage of d-limonene. This results in lower optical rotation values since d-limonene is the most optically active component in the oil. Quality of the oil depends upon properties which are influenced by the yield obtained; the yield in turn is determined by operational procedure of the equipment used and other processing techniques.

Analyses of expressed oils of orange secured during the 1948-49 season compare favorably

TABLE 1—RELATION OF YIELD TO THE CHARACTERISTICS OF FLORIDA COLDPRESSED OIL OF ORANGE

Yield Lb. Oil/ Ton Peel	Specific Gravity 25°C./25°C.		Evaporation Residue %		Optical Rotation 25 D		Refractive Index N20D		Ester Content %		Method of Extraction
	1947-48	1948-49	1947-48	1948-49	1947-48	1948-49	1947-48	1948-49	1947-48	1948-49	
9.70	0.8448	0.8448	3.60	4.04	+95.66	+95.05	1.4732	1.4739	0.94	1.08	Fraser-Brace Extractor
7.00	0.8430	0.8431	2.18	2.46	+96.49	+96.16	1.4724	1.4732	0.51	0.77	Pipkin Juice Extractor
4.90	0.8422	0.8421	1.92	1.75	+97.11	+97.07	1.4721	1.4729	0.51	0.64	Screw Press
1.85	0.8423	0.8423	1.32	2.06	+97.41	+97.51	1.4719	1.4727	0.58	0.49	Pipkin Roll

with the 1947-48 results in that they indicate that the oils produced by some of the manufacturing processes at certain times during the season did not meet the U. S. P. specifications, because some of the processes resulted in yields which were too low or too high. Only one method of extraction gave yields throughout both seasons so that the oil consistently met the requirements of the U. S. P. However,

TABLE 2. THE ALDEHYDE CONTENT OF FLORIDA COLDPRESSED OIL OF ORANGE.

% Aldehyde Content		Method of Extraction
1947-48	1948-49	
1.93	1.60	Pipkin Juice Extractor
1.91	1.66	Pipkin Roll
1.58	1.23	Fraser-Brace Extractor
1.47	1.46	Screw Press
1.73	1.49	All Methods (Average)

it is apparent that if oil is extracted in such a manner that the yield falls within a certain range (45 to 60 percent of the total amount of recoverable oil in the peel of any variety of fruit of good maturity), then it will meet U. S. P. specifications.

In Table 1 a correlation is shown between the ester content and yield of oil secured from the peel for the 1948-49 season. As the yield increased the values for ester content increased. This correlation was not evident during the 1947-48 season.

Effect of Seasonal Variations on Properties.—The 1947-48 season was considered to be a very wet season; whereas, the 1948-49 season was considered to be a very dry season, and it would be expected that yearly variations of this kind would cause some differences in the physical and chemical characteristics of the oil. However, there were only two factors which were affected to any extent by seasonal differences. These were refractive index and aldehyde content. The values for refractive index averaged 0.0008 of a unit higher during the 1948-49 season. In the case of those processors who obtained high yields of oil, a difference of this magnitude would result in the oil having values which would exceed the U. S. P. standards for this requirement Oils produced by the Fraser-Brace extractor as shown in Table 1 gave values of refractive index which were too high; whereas, during the 1947-48 season satisfactory values were obtained. As shown in Table 1 the Pipkin roll and screw press methods of extraction, which obtain low yields of oil, gave oils during the wet 1948-49 season which met the U. S. P. requirements for refractive index; whereas, during the dry 1947-48 season values were too low.

Aldehyde Content of Florida Oil of Orange.—The aldehyde content of the oil, although not included in the U. S. P. specifications, is indicative of the flavoring qualities of the oil. Although other constituents are also very important from a flavor standpoint, aldehydes are a predominant factor in orange and other citrus oils. The average value for the aldehyde content of oil produced during the 1948-49 season by all processes as shown in Table 2 was 1.49 percent. A similar value for the 1947-48 season was 1.73 percent. The difference between these two values gives a decrease of 16.1 percent in the aldehyde content of oil produced during the 1948-49 season. Apparently the dry weather had some physioligical effect on the fruit which resulted in a lower aldehyde content of the oil.

Summary

Commercial methods of production of oil of orange in Florida during the 1947-48 and 1948-49 seasons have been studied and compared.

The quality of oils of orange, as indicated by their physical and chemical characteristics, is determined by the yield of oil obtained in any commercial process. Climatic variations were found to be a factor which affected some of the properties of expressed oil of orange.

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FROZEN PUREES FROM FLORIDA CITRUS FRUITS

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The earliest development in the art of food preservation was undoubtedly inspired by the need of extending food supplies beyond normal seasonal limits. Following early successes a second objective was introduced: that of improving the quality of the product. Food processors of today are keenly interested in maintaining the highest quality possible.

It has been only in fairly recent years that the search for better processing methods to obtain high-quality products has turned to freezing and frozen storage. It is true that as early as 1905 small fruits packed in sugar syrups were frozen in the eastern United States and that in 1909 "cold pack" berries were processed in the Pacific Northwest. It later became apparent that many users would prefer a mashed or pureed material to whole fruit. Consequently, in 1931, the Bureau of Agricultural and Industrial Chemistry instituted investigations at its laboratory in Los Angeles, California which resulted in the development of a whole new series of fruit and berry purees suited to frozen storage methods.

Citrus fruit purees were not originally included in this program as it had been thought that such products would be too strong in flavor and might develop "terpeney" off flavors in storage. In 1947, however, citrus puree investigations were inaugurated at the Fruit and Vegetable Chemistry Laboratory, Los Angeles, California, under the direction of Dr. E. A. Beavens[1]. Preliminary work was done near the end of the Valencia orange season and the results were so promising that the successful commercial production began the following year.

As a result of the wide interest in and the active market demand for citrus purees, namely, the orange and lemon purees now produced in California, the Citrus Products Station at Winter Haven, Florida, instituted investigations during the 1948-49 season to determine the adaptability of the Florida citrus fruits to this type of product. As the work began at the height of the Valencia orange season, this variety was chosen for the initial investigations. The results indicate that an excellent frozen puree can be prepared from this fruit.

Other varieties of citrus fruits were tested including tangerine, Tardia lime, Persian lime, and Key lime. It is anticipated that additional orange varieties will be used during their respective seasons in the coming fruit year.

METHODS OF PROCESSING

The method of processing the fruit was essentially that developed at the Los Angeles laboratory[1]. It consisted of thoroughly washing sound, mature fruit, preferably with a good detergent and rinsing with cool or cold water, followed by halving or quartering the fruit, depending on size, and passing through a laboratory model Chisholm Ryder Sep-ro-siv* fitted with a screen of 0.27-inch openings. This machine operates on the principle of a tapered screw within a conical screen with the juice, peel oil, and some pulp being forced through the screen while the seeds, rag, and remainder of the rind are ejected at the small end of the screw flight. Openings larger than 0.27-inch allow the passage of particles of pulp of such size as to be objectionable in the end product. The puree obtained from the Sep-ro-siv was fortified with sucrose (1 part sucrose to 5 parts puree by weight) and after thorough mixing was canned and quickly frozen.

Purees stored at 0°F. for eight months show no apparent change in color, flavor or vitamin C content. Dr. Beavens[1], who has studied such products over longer periods, finds that they may be kept in good condition for more than a year. The puree may be defrosted, a

[1] Agricultural Chemical Research Division Contribution No. 252.

[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

* The mention of certain trade products does not imply that they are endorsed by the Department of Agriculture over similar products not mentioned.

portion used, and the remainder refrozen without injury to color or flavor, provided it is not exposed to the air for long periods nor the temperature of the product allowed to rise too high.

The importance of using good clean fruit is self-evident, as there is no pasteurization or other biological control during processing. By the same token it is essential that once started, the preparation be carried to completion as rapidly as possible.

Discussion

Orange Purees

The yield of puree from Florida Valencia oranges has been found to be in the range of 55 to 60 percent by weight of the whole fruit, and contained about 18 percent suspended solids, 1 percent citric acid and 1 percent peel oil. This percentage of oil is comparable with that contained in commercial California purees. The values may be expected to vary with varieties and seasons.

Purees prepared at the Citrus Products Station have been evaluated through the medium of milk sherbets. An orange sherbet containing 6 to 7 ounces of sweetened puree per finished gallon was judged superior to any locally available orange sherbets, including that of a nationally advertised brand. It was also judged superior to an experimental orange sherbet containing 48 ounces of freshly extracted juice instead of puree, a product judged superior to any commercial sherbet. It appears that peel oil is a major flavor factor in citrus purees since a small proportion of orange puree of high oil content produced a milk sherbet judged superior to a similar sherbet containing a large proportion of freshly extracted juice of low oil content. It is thought that one of the reasons for the high quality of the products prepared from citrus purees may be the high percentage of oxygenated constituents[2] in the emulsified peel oil it contains. While the oxygenated constituents have not been determined in this product, it is well known that the usual methods of manufacturing peel oil results in a partial loss of them because of their partial solubility in water. These constituents are largely responsible for the characteristic flavors and aromas of citrus peel oils. In the manufacture of puree there is no chance for them to escape.

Sherbet Formula

The sherbet formula used with the orange and other citrus purees was as follows:

Gelatin	0.5 ounces dissolved in 2 ounces boiling water
Milk (evaporated)	12.5 ounces
Sucrose	2.0 pounds
Dextrose	12 ounces
Orange puree	8.7 ounces
Citric acid (50% Soln.)	Approx. 1 ounce to give characteristic flavor
Certified food coloring	to give characteristic color.
Water	to make one gallon.

The above formula represents about .75 percent butter fat and 1.2 percent serum milk solids. There seems to be quite some variance in the butter fat and serum solids concentration used by commercial sherbet manufacturers but in general the values run in the order of 2.0 to 2.5 percent of each. A supply of a commercial sherbet base containing 2 percent butter fat and 3 percent serum solids was obtained and used in the preparation of sherbets using varying proportions of orange puree. It was found that the higher milk solids base masked the delicate orange flavor. Increased concentration of the puree did not overcome the masking of flavor but only raised the peel oil content of the product to the point that it was quite objectionable.

Tangerine Purees

A tangerine puree was prepared from overripe fruits which were obtained after the close of the normal processing season (1949) for this fruit. The sherbet prepared from this puree was judged excellent when fresh, having the flavor of prime quality tangerines, but after a few days the sherbet had developed an off flavor much like that of stale fruit. Later a second portion of the puree was used in preparing an identical sherbet with the same result. Thus it is indicated that the flavor change takes place after preparation of the sherbet and not in the frozen puree. Further work with this fruit is necessarily postponed until next season's crop is available.

Lime Purees

Investigation of lime purees was undertaken in the late spring of 1949, again after the

close of the normal season for this fruit. The only variety available was the "Tardia" which, like the tangerine, was over-ripe; and the fruits, though found to be normally acid, had lost all their characteristic lime odor and flavor. The sherbet prepared from the puree was quite palatable and tart but did not have the characteristic lime flavor. Later, when the first limes of the current season began to move to market, some of the "Persian" variety was processed. In the resulting sherbet it was found that a bitter characteristic present in the rind of the fruit had been incorporated in the product making it unpalatable. Sometime later more mature Persian limes were obtained and processed to determine whether the degree of maturity influenced the presence of the bitter characteristic. Experiments to date have shown no abatement of this objectionable bitterness as the season progressed.

Since the bitter flavor was obtained with green Persian limes, a puree of ripe Key limes was made to see whether these gave the same result. The sherbet exhibited the same bitter characteristic previously encountered though perhaps to not quite such an extent as that of the Persian variety.

It is planned that investigations will continue on both these lime varieties and on others as they become available during the coming fruit season. Since lime sherbet is one of the most popular sherbets, it is thought that lime puree would offer an excellent opportunity if the right combination can be found.

SUMMARY

Citrus purees have been prepared from a number of varieties of Florida fruits by the method developed at the Fruit and Vegetable Chemistry Laboratory in Los Angeles, California. The purees were evaluated through the medium of milk sherbets. Florida Valencia orange puree is recommended as an excellent product for use in preparing orange sherbets of superior flavor appeal. It is also suggested that a lower total milk solids sherbet mixture be used than that of present commercial practice in order to obtain the true flavor characteristic of the fruit.

Tangerine and lime puree cannot be recommended at this time. Lemon and other orange varieties will be investigated during the coming season.

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THE VITAMIN P CONTENT OF FROZEN ORANGE CONCENTRATE

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From time immemorial the therapeutic properties of citrus fruits have been recognized by the medical profession. In China, where citrus trees were cultivated for thousands of years before they were brought to Europe, the value of oranges for health has long been common knowledge. In old Chinese manuscripts and medical treatises of a thousand years ago, one may find here and there an indication that oranges should be used in bleeding and exhaustion. One may also read about the use of citron in diseases of the joints, so common in ancient Greece, in the writings of philosophers and physicians of that epoch.

Although scurvy was known for centuries and described by Euricius Cordus in 1534, the famous British surgeon John Lind was the first to explain, as early as in 1757, the symptoms of scurvy and to demonstrate that the bleeding characteristics of this disease can be arrested promptly by the generous use of citrus juice.

Thus long before the actual discovery of the vitamins C and P, physicians were well cognizant of the fact that there is in citrus fruit a valuable substance or substances which are essential for human health and the absence of which causes a grave and often dangerous disease. And for many years the medical profession all over the world has recommended and prescribed the use of citrus fruit for the maintenance of good health although ignorant of the substances present there.

The isolation in 1927 of vitamin C from oranges by the Hungarian physician and chemist, Albert Szent-Gyorgyi was the turning point as far as the consumption of citrus fruit in this country was concerned. It was the beginning of a gigantic promotion of orange juice based exclusively on a "health angle." Orange juice is essential for the health of all of us, and of children in particular—this has been stated again and again in articles published in medical journals, in popular magazines and newspapers.

This "health promotion" gave a strong push to the citrus industry of Florida. It was partially responsible for the fast growth of the canned orange juice industry in this state. As a matter of fact there was no canned orange juice made in Florida until 1929 and only when the medical profession began to recommend "Orange juice for children," an increased interest in the technology of canned citrus juice brought about the production of canned orange juice which actually started at that time. In 1929-30 only 38,000 cases of orange juice were produced. But in 1934-35 already 241,000 cases were sold because through this decade the health promotion campaign had gone on unabated—indeed stronger than ever!

Seemingly the "health value" of orange juice has been the chief moving force in the growth of the consumption of this juice. The health angle in the consumption of citrus fruit still remains, in our opinion, a dominating factor. And yet, strange as it may seem, the present day promotion campaign pays little attention to the health angle and much effort is concentrated on selling orange juice just for its "good taste." It is the purpose of this paper to emphasize once more the health value of orange juice and to present some new data concerning this question.

When Szent-Gyorgyi isolated vitamin C in pure form and investigated its biological activity, he became convinced of the presence of a substance which worked as a co-enzyme to ascorbic acid. But only in 1936 was he able to announce the discovery of vitamin P. In the beginning he called this vitamin "citrin," as being isolated from lemon, but soon he renamed it Permeability factor, using the letter P for the new substance. A few months after the publication of their first paper, Szent-Gyorgyi and his associates made an important correction to their original statement. Citrin was not a pure substance but a combination of three glycosides which, however, apparently formed a complex molecule in an unknown fashion.

When separated these substances were identified as hesperidin, eriodictin and a quercitrin-like substance. An extensive clinical investigation was conducted by Szent-Gyorgyi and associates[1]. They found that vitamin P, as prepared by them, has a strong and definite medicinal value. This vitamin improves the function of small blood vessels, the capillaries, decreases their fragility and arrests bleeding present in so-called hemorrhagic diathesis[2]. Injections of vitamin P produces a decrease of blood pressure in animals and men[3].

During the last ten years, considerable work has been conducted on vitamin P in this country and abroad. Many efforts have been made to determine what is the structure of the active vitamin P factor. In his original work Szent-Gyorgyi postulated that the configuration of the 1 and 2 carbon atoms in the benzopyrone compound is of special importance for vitamin P activity. He furthermore stated that a double bond at carbon atoms 2 and 3 and an OH at carbon atom 3, as in the case with quercitrin, is sufficient to abolish the activity. More recent investigations by Higby[4], Hughes and Parker[5], Sokoloff and Redd[6], have indicated that the double bond at carbon atoms

2 and 3, contrary to Szent-Gyorgyi's opinion, seems to be essential for Vitamin P activity. Moreover, the position of the sugar molecule seems to be of secondary importance although this question is still under discussion. The fact remains that a complex molecule of glycosides, such as is apparently present in "citrin," is more effective therapeutically than the purified compounds such as chalcone hesperidin, eriodictyol glycoside or quercitrin. We may add that it is generally admitted that the water-soluble compounds exert a much higher activity than the water-insoluble ones. Thus, pure hesperidin actually shows very little if any capillary permeability activity.

From the time that ascorbic acid was isolated in pure form and as such widely used in medical practice a vast information was accumulated to the effect that this substance is not sufficiently effective when given alone in certain types of bleeding. E. W. Crampton and Barbara W. Burton of McGill University investigated the effect of orange juice and pure ascorbic acid on guinea pigs. They arrived at the conclusion that "orange juice contains some substance which enhances the utilization of the ascorbic acid present," and therefore, orange juice is more active than ascorbic acid alone. Numerous other investigators (Fox and Stephen, Giround, Leblond and Ratsimamanga, Hawley, Daggs and Stephens) corroborated these findings. When orange juice is given instead of pure ascorbic acid the adrenal gland is more rich in vitamin C which indicates that the reserves of the body in this substance are increased. Even more impressive in this respect was the work of E. Todhunter, R. Robbins, G. Ivey and W. Brewer of State College of Washington[7]. They studied the effect of crystalline ascorbic acid and lemon juice respectively on guinea pigs. They paid particular attention to the adrenal gland which is assumed to be a "regulating center" for this vitamin. The animals which received ascorbic acid alone had an abnormally enlarged adrenal gland and they also manifested a tendency for bleeding (skin bleeding). On the other hand, the guinea pigs fed on lemon juice showed no signs of bleeding and their adrenal gland was not only normal in size and structure but its vitamin C content was much higher than in the animals receiving ascorbic acid in tablet form.

All these facts and observations, even if some of them were not very conclusive, suggested that in orange juice there must be some other factor than ascorbic acid which exerts a beneficial effect upon the capillary system and which enhances the action of vitamin C in this direction. Apparently this factor is vitamin P, the presence of which in orange juice has such a therapeutic action.

Orange juice is a rich source of vitamin P. Many investigators were able to demonstrate the beneficial effect of vitamin P compound extracted from oranges on capillary fragility. Ralph H. Higby[8], of the California Fruit Growers Exchange, states that "oranges derivatives were effective in controlling capillary permeability and fragility." C. H. Thienes of the University of Southern California Medical School has shown that the water-soluble yellow substance derived from orange was active in reducing blood pressure[9]. C. Z. Wawra and J. L. Webb disclosed that this substance seemed to be effective in decreasing capillary fragility[10]. S. Scarborough used orange juice in capillary fragility with uniformly successful results. Similar results were obtained by him with an extract from orange containing the factors of vitamin P[11]. Kugelmass has also demonstrated the effectiveness of vitamin P from oranges in curing several cases of so-called vascular purpura. In this disease, as a rule, an extensive bleeding in the skin occurs[12]. But the most convincing and well elaborated investigation was conducted by A. L. Bacharach and his associates[13]. They took young albino guinea pigs and placed them on a diet of bran, crushed oats and separated milk powder. This diet is free or almost free from vitamins C and P. Their capillary fragility was measured by a very sensitive apparatus. The animals were divided into three groups. One group received only Vitamin C in relatively large doses. The second group was given ascorbic acid and vitamin P compound extracted from orange juice. And the last group re-

ceived hesperidin and ascorbic acid. While the first group in three weeks showed very pronounced capillary fragility, the second group, which was kept on the vitamin P from orange juice, retained a normal capillary system. Hesperidin gave only a slight improvement in the condition of the animals.

The bulk of the vitamin P fraction of orange juice consists of chalcone hesperidin and glucose-hesperidin complex. Two other substances found in relatively small amounts are eriodictin and quercitrin. Our investigations seem to be in full accord with those reported by other workers although we were able to identify more definitely the factors from which the vitamin P complex of orange juice is composed.

Our present report is primarily concerned with the vitamin P content of frozen orange concentrate. During the season 1948-49, the Birds Eye Snyder Division of General Foods submitted to us a number of samples of frozen orange concentrate produced at their Florida plants at various times of the season.

The testing of orange juice, either concentrated or regular for vitamin P offers considerable difficulties as far as the technique is concerned. In order to estimate properly the vitamin P factors of juice, these factors should be extracted from the juice in as pure as possible form. Otherwise spectrophotometry might give unreliable results. For the isolation of vitamin P factors we have been using a chromatographic adsorption technique. By this method all or almost all vitamin P factors can be properly extracted and obtained in relatively pure form, The material thus isolated was tested chemically by color reactions as respectively described by Lorenz, Wilson and Jeney. The reading was taken by Coleman spectrophotometer and rechecked by Ultra-Violet curves. The maximum adsorption for chalcone-hesperidin fraction by Wilson's test was 425 millimicrons with a specific extinction coefficient of 3.83. The ultra-violet readings gave a maximum adsorption beyond the 220 mu. range with a small peak at 251 mu. This compares to a 450 absorption peak for California Fruit Growers' Methyl Chalcone Hesperidin by the Wilson test. The specific extinction coefficient is 10.2. In the Ultra-violet the maxima occur at 285 mu. and 343 mu. with a specific extinction coefficient of k (285 mu.) 23.01 and k (343 mu.) 11.65.

Considerable attention was paid to the bioassaying of the vitamin P material extracted from juice. We used the method of Ambrose and DeEds, which is based on capillary permeability of methyl blue dye injected simultaneously with the vitamin P compound into a rabbit. This method makes it possible to measure, with a considerable degree of accuracy, the potency of the material as expressed in terms of the time required for the diffusion of dye through the capillary wall. The bioassays gave us unquestionable proofs that the factors present in orange juice manifest capillary permeability activity. This activity seems to depend much more on chalcone-hesperidin compound than on eriodictin and quercitrin. But, on the other hand, these last two compounds seem to produce a decreasing effect upon blood pressure. Thus it appears that the factors present in orange juice exert two different activities: some factors decrease capillary fragility, while the others decrease blood pressure. But physiologically speaking both work in the same direction by improving the functioning of the capillary system. Even more reliable method to test vitamin P activity is its protective action against radiation. The results of our investigation on this subject are reported elsewhere[14].

The samples of frozen orange concentrate of the same day's production gave identical figures of vitamin P potency but the samples of two different productions showed considerable variety in vitamin P content, depending on the season of production and perhaps on the type of fruit used. From Table One it appears that juice manufactured in January and February is of a relatively low vitamin P content, averaging about 10 milligrams of vitamin P in January and 12.5 milligrams in February per 100 ml. of concentrated juice.(*) Frozen orange concentrate produced in the first days of December showed a vitamin P potency below 8.0 mgs. However, these

samples were obtained from another source and are therefore not included in the table. In March, orange juice showed a sharp increase in the potency reaching its peak in June. An average for March and April is about 21.4 mgs. per 100 ml. concentrate while in May the potency is close to 23.0 mg/100 ml. concentrate. Frozen orange concentrate tested in June gave an even higher average, about 25.0 mgs. per 100 ml. concentrate. (See Table I).

TABLE I. VITAMIN P CONTENT OF FROZEN ORANGE CONCENTRATE

Sample Code	Date of Manufacture	Vitamin P Content mg./100 ml. Concentrate
OJ 2 BB	Jan. 2 1949	9.8
OJ 3 BB	Jan. 3, 1949	11.4
OJ 8 BB	Jan. 8, 1949	12.4
5 J7HB	Feb. 26, 1949	13.4
8 J 4 BB	March 25, 1949	21.4
9 J 8 BB	April 8, 1949	21.4
3 K 5 BB	May 15, 1949	22.8

(*) The compound isolated from orange juice was pure or almost pure (0.4% of impurity) and although it contained four different glycosides their chemical analysis gave a specific sum-total of the active factors. After this compound was tested by Ambrose-DeEds technique its biological activity was re-checked by x-ray radiation method. Five milligrams of this compound gave a protection to a rat, 150 grams of weight, against radiation (800 r) when administered for 30 days, 7 days prior to radiation and 23 days post radiation.

From this investigation, one may see that frozen orange concentrate has in May double the amount of vitamin P of that manufactured in January, and nearly three times the amount of this factor as compared with juice produced early in the season. These findings correspond to the results of our investigation of fresh and canned orange juice. They indicate that the greatest value of juice from a medicinal view point is when very ripe fruit is used for the production of juice. It is a ripe orange that contains the largest amount and the most active form of vitamin P.

Conclusion

It is estimated that about five million people in this country alone have abnormally high blood pressure. In some instances, when actual essential hypertension is present, the blood pressure might reach a dangerously high peak, in many other cases the blood pressure is only relatively elevated. But in all cases when blood pressure is above the normal level there is a danger that the capillaries will not be able to withstand the pressure. For the fragility of capillaries increase with age. While a child has a very high resistance of the capillary wall, a man over forty might already manifest some degree of abnormal capillary fragility. Sudden death might be caused in some cases by the breakdown of the capillary wall and consequently profuse internal bleeding. A hemorrhage may take place in the brain, or in the heart, or stomach, or eye. Thus the necessity of maintaining the capillary system in good condition is becoming an urgent and important problem of medical science today, as well as of scientific nutrition. As in many cases of chronic ailment, preventive measures are much more effective than the treatment of an already present condition. In this respect it seems to be essential that every person approaching middle age should receive in their diet an ample amount of vitamin P, a factor which takes an active part in maintaining the capillary system in good condition. The best source of vitamin P in its most active form so far discovered, is orange juice. And yet as we said, only the juice from ripe fruit is rich in this factor. It

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appears that 20 milligrams of vitamin P a day might be a sufficient dose to keep the capillary system in healthy condition. Thus a six ounce can of frozen concentrate manufactured in April-May will supply the minimum daily requirement dose of this factor. But a can produced in December or even in January will *not* give a sufficient amount of this essential vitamin and it should be necessary to take two six-ounce cans per day which is somewhat too large an amount to drink daily.

Bringing these observations to the attention of citrus producers we would like to stress very strongly the importance and health value of vitamin P of orange juice and the necessity and even urgency of further investigations along these lines.

GEL FORMATION IN FROZEN CITRUS CONCENTRATES THAWED AND STORED AT 40° F

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Lake Alfred

The quality of frozen citrus concentrates will be greatly lowered if storage temperatures during transportation and in the frozen food cabinets in stores and homes are not sufficiently low to keep the citrus concentrates frozen. Desirable qualities of a frozen citrus concentrate are that it be free from lumps and that on reconstitution the juice will retain the physical appearance of fresh juice. It has been noted that gel-like particles formed in some samples of frozen grapefruit concentrates that had been stored at usual household refrigerator temperatures for about one week, and prolonged storage resulted in the formation of a solid gel. Curl *et al.*[6] found that orange concentrates which were unpasteurized but benzoated became lumpy when stored at temperatures from 40° to 120°F.

The principle object of this investigation was to determine the cause of gelation in unpasteurized citrus concentrates. In establishing the cause of gelation, data were secured in reference to the relation between the degree of gelation and methoxyl content of the pectin, pectase activity, and rate of separation of reconstituted citrus concentrates.

EXPERIMENTAL PROCEDURE

Collection and Storage of Samples.—Seven packs of frozen citrus concentrates processed during the 1948-49 season at the Citrus Experiment Station were used for this investigation. Information on these packs of unpasteurized frozen concentrates is presented in Table 1.

TABLE 1. FROZEN CITRUS CONCENTRATES STORED AT 40°F.

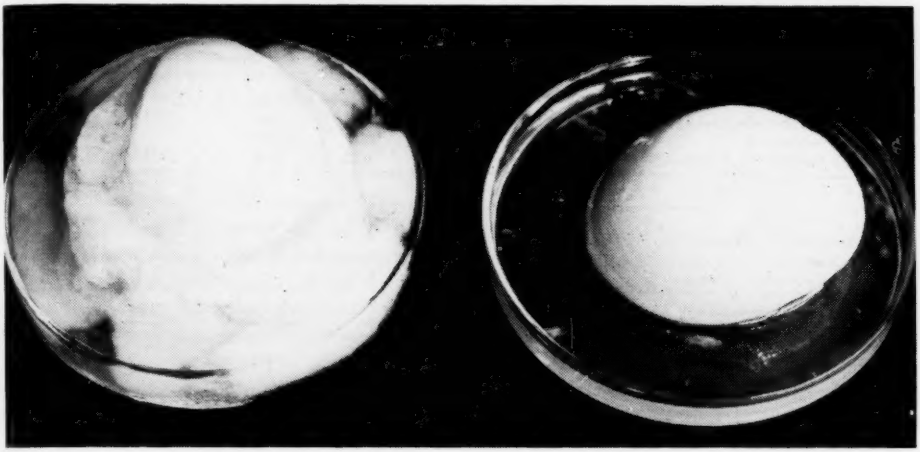
Sample	Date Processed	Type	Variety	°Brix Refractometer—28°C	pH
1	3-15-49	Grapefruit	Duncan Marsh	38.1	3.2
2	4-20-49	Grapefruit	Seedless Duncan	38.3	3.5
3	4-21-49	Grapefruit	(Late bloom)	38.5	2.9
4	11-17-48	Orange	Hamlin	43.4	3.5
5	4 -5-49	Orange	Valencia	42.0	3.5
6	5 -5-49	Orange	Valencia	42.0	3.7
7	2 -8-49	Tangerine	Dancy	42.5	4.1

Samples of the concentrates were removed from storage at 0°F. and placed in the 40°F. storage room. These samples were taken for examination periodically as shown in Tables 2 and 3.

Method of Analyses.—An alcohol precipitate was prepared from each sample of concentrate, dried, redissolved in distilled water and clarified for the determination of calcium pectate and the methoxyl content of the pectin. The pectic content was determined by the Carre and Haynes[3] calcium pectate method. The methoxyl content of the pectin was determined by saponification and expressed on a calcium pectate basis.

The pectase activity in the citrus concentrate was determined by the method of Kertesz[7], which he used in working with tomato juices. Pectase activity is considerably

Fig. 1—Gelation of frozen citrus concentrates caused by low methoxyl pectin produced during storage by the enzyme pectase.



Left—Orange concentrate—sample 4—semi-gel Right—Grapefruit concentrate—sample 1—solid gel

greater (approximately 10 to 20 times) in tomato products as compared with that found in citrus juices. The pectase activity was expressed in units per milliliters and per gram of total solids in the concentrate.

The rate of separation of the insoluble solids was determined on the reconstituted juices prepared by adding three parts of water to one part of frozen concentrate. The amount of separation was determined by placing 100 ml. of the reconstituted juice in a 100 ml. graduated cylinder and noting, after fifteen minutes, the amount of liquid free of pulp.

Experimental Results and Discussion

Processors of frozen citrus concentrates in Florida for the past few years have been using the process of MacDowell *et al*[1]. This juice may or may not be pasteurized. Since frozen

TABLE 2. PHYSICAL AND CHEMICAL PROPERTIES OF FROZEN GRAPEFRUIT CONCENTRATE STORED AT 40°F.

Days Stored	0	6	12	18	24	30
			Sample 1			
Degree of Gelation	None	Slight	Semi-gel	Solid gel	Solid gel	Solid gel
Separation in 15 minutes—%	40	49	48	50	58	59
Calcium Pectate—%	0.16	0.15	0.15	0.10	0.12	0.16
Methoxyl Content of Pectin—%	4.67	4.46	4.33	3.99	3.41	3.22
			Sample 2			
Degree of Gelation	None	None	Slight	Slight	Slight	Semi-gel
Separation in 15 minutes—%	0	28	28	30	40	41
Calcium Pectate—%	0.08	0.12	0.08	0.06	0.09	0.12
Methoxyl Content of Pectin—%	5.96	5.60	4.83	4.28	3.54	2.76
			Sample 3			
Degree of Gelation	None	None	None	None	Slight	Slight
Separation in 15 minutes—%	0	0	0	2	3	3
Calcium Pectate—%	0.10	0.13	0.13	0.14	0.15	0.19
Methoxyl Content of Pectin—%	7.97	7.20	7.09	7.02	6.87	6.66

TABLE 3. PHYSICAL AND CHEMICAL PROPERTIES OF FROZEN ORANGE CONCENTRATES STORED AT 40°F.

Days Stored	0	6	12	18	30
			Sample 4		
Degree of Gelation	None	Slight	.....	Slight	Semi-gel
Separation in 15 minutes—%	12	20	.....	21	25
Calcium Pectate—%	0.16	0.14	.....	0.13	0.16
Methoxyl Content of Pectin—%	6.81	6.53	.....	6.11	5.87
			Sample 5		
Degree of Gelation	None	.....	Slight	Slight	Slight
Separation in 15 minutes—%	0	3	10	18	25
Calcium Pectate—%	0.15	.....	.....	0.08	0.12
Methoxyl Content of Pectin—%	6.73	.....	.....	5.03	4.63
			Sample 6		
Degree of Gelation	None	.....	None	None	Slight
Separation in 15 minutes—%	0	2	9	16	25
Calcium Pectate—%	0.14	.....	.....	0.11	0.09
Methoxyl Content of Pectin—%	6.53	.....	.....	5.31	4.56

citrus concentrates produced in Florida are unpasteurized, any pectic enzymes present have not been inactivated. Pectase, which demethylates pectin is also known as pectin-methoxylase and pectin-esterase. A partially demethylated pectin will combine with the calcium present to form calcium pectinate, which under proper hydrogen ion concentration will form a gel. The firmness and amount of gel formed depends on the pH and the quantities of low methoxyl pectin, calcium and soluble solids present[1,2].

Degree of Gelation.—The degree of gelation was expressed as none, slight, semi-gel, and solid gel. A slight gel is one where lumpy particles are present in the concentrate. A semi-gel and a solid gel are shown in Fig 1. Grapefruit concentrate, sample 1, and orange concentrate, sample 4, showed gelation at the end of six days' storage at 40°F. The tangerine concentrate, sample 7, was the only one which showed no gelation after 60 days of storage at 40°F. Results shown in Table 4 indicated that in the case of orange concentrates, the degree of gelation increased on prolonged storage at 40°F.

Relationship of Low Methoxyl Pectin To Gelation.—The factor found to have the most influence on gelation in the frozen citrus concentrates was the presence of low methoxyl pectin. As shown in Tables 2 and 3, as the storage time was increased, the methoxyl content of pectin decreased and gelation increased. However, gelation was not always accompanied by demethylation. For example, orange concentrate, sample 6, showed a pectin with 5.31 percent methoxyl content but no gelation after being stored for 18 days at 40°F.; however, sample 4, which had a pectin with a methoxyl content of 6.53 percent, when stored for six days at 40°F. showed slight gelation. The major difference between these two samples was pH. The former had a pH of 3.7 which is out of the gelation range, while the latter had a pH of 3.5 which is just on the border of the pH gelation range. Baker and Goodwin[3] discussed pH along with other optimum conditions for gel formation with low methoxyl pectins.

Relationship of Pectase Activity to Gelation.—A greater degree of gelation was found in those concentrates having the higher pectase activity. In Table 4 is presented the pectase activity in the citrus concentrates studied and the degree of gelation after 30 and 60 days at 40°F.

Data in Table 5 show the pectase activity in orange concentrates of varying solids content, which were prepared from the same juice and stored at 0°F. From these results pectase activity is indicated to be a function of concentration, being less active at 23.6° and

TABLE 4. PECTASE ACTIVITY AND GELATION IN FROZEN CITRUS CONCENTRATES

Sample	Type	Pectase Units per ml.	Pectase Units per g. Solids	Degree of Gelatin at 40°F Storage	
1*	Grapefruit	2.2	5.0	Solid gel	Solid gel
2	Grapefruit	1.6	3.6	Semi-gel	Semi-gel
3	Grapefruit	0.8	1.9	Slight gel	Slight gel
4	Orange	3.5	6.7	Semi-gel	Semi-gel
5	Orange	2.8	5.7	Slight gel	Semi-gel
6	Orange	3.6	7.3	Slight gel	Semi-gel
7	Tangerine	0.1	0.2	None	None

*5 ml. of each concentrate used.

59.2° Brix and most active at 41° Brix. Cotton *et al.*[4] found a similar relationship between degrees Brix and clarification rates of juices reconstituted from orange concentrate. Clarification in this case was undoubtedly caused by the pectin enzyme activity.

TABLE 5. RELATION OF °BRIX OF FROZEN ORANGE CONCENTRATE TO PECTASE ACTIVITY

°Brix at 28°C.	Pectase Units Per ml.	Per g. Solids
23.6	0.7	2.6
33.2	1.6	4.1
41.0	2.5	5.1
50.4	2.6	4.2
59.2	2.1	2.7

Relationship of Gelation to the Separation of Reconstituted Juices.—The data presented in Tables 2 and 3 show that as gel formation appeared and increased with storage, the rate of separation increased. Those samples which showed no gelation or only slight gelation and which had higher methylated pectins definitely retained a colloidal cloud after the pulp separated, and this cloud became clearer as gelation increased with storage time. The two samples that formed gels, shown in Fig. 1 were very unstable juices when reconstituted and a water clear liquid resulted upon separation. Therefore the pectin in a frozen concentrate should be protected from de-esterification and degradation, if a stabilized reconstituted juice is desired.

Inactivation of Pectic Enzymes.—Very few studies have been reported on the activity of pectic enzymes in citrus juices, especially as to the relative rates of heat inactivation. Kertesz[7] who studied the pectase activity in tomato juice reported that the enzyme can be inactivated at 176°F. for 45 seconds. Joslyn and Sedky[6] reported that the inactivation, based on clarification studies, of pectic enzymes in orange juice, pH 4, was accomplished by heating either for nine minutes at 140°F. or one minute at 212°F. The complete inactivation of the pectic enzymes may not be necessary since the data showed that when the activity in the concentrates was approximately 2 units only slight gelation occurred in 60 days when it was held at 40°F. Further studies are being conducted on the inactivation of the enzymes present in citrus juices.

Summary

The data presented verifies that the presence of low methoxyl pectin, which resulted from the activity of the enzyme pectase is the cause of gelation in frozen citrus concentrates during storage at 40°F.

In all of the reconstituted juices the rate of separation increased as the degree of gelation in frozen citrus concentrates increased.

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THE ROLE OF MICRO-ORGANISMS AND STORAGE TEMPERATURES ON THE QUALITY OF ORANGE CONCENTRATE

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An estimated volume of ten million gallons of concentrated orange juice was prepared by Florida's frozen concentrate plants last season. Frozen concentrate holds a favored position among the citrus fruit products manufactured by the plants in Florida and has won an enviable place among the consumers' purchases of frozen foods. This huge and rapidly growing industry must use every means possible to safeguard its product.

Many factors are of importance for the production and marketing of frozen orange concentrate and proper maturity, control of the Brix-acid ratio, rapid handling of the fruit, plant sanitation, control of peel oil, and suspended solids content. Another important factor is the maintenance of proper temperaatures during storage, transportation, and distribution of the product. This discussion is concerned with observations on the effect of storage temperatures above freezing in causing deterioration of the concentrate. The containers generally carry specific instructions as to the frozen storage temperature—usually to the effect that the product must be kept frozen until used. Laxness in this respect during storage or on the part of the distributor, retailer or consumer would tend to mar the superior quality of this delicious product. The present paper is a report merely of microbiological examinations of samples of Florida orange concentrate, made at room temperature before storage and after storage at different temperatures and for different periods with the object of determining the relation between microbiological activity and the time and temperature of storage; as well as the role of each in affecting the quality of the product. The minimum temperature required to inhibit growth in stored concentrate was not determined in this study.

The specimens of concentrate used in this study was collected from each of the Florida plans producing orange concentrate at intervals during the 1948-49 season, packed in crushed ice, and taken to the laboratory. One specimen was used for plating as soon as it arrived; one was packed in the "zero room" (approximately -2° F.) and when a third specimen had been collected, it was placed beside the cooling unit in an electric refrigerator 42° F. to stimulate storage conditions found in many households and frequently observed in holding cabinets of retail stores. Since the refrigerator employed in this study was one in general use and was opened many times during the day, the conditions of the experiments further approximated those of food storage in a household refrigerator when storage outside of the freezing compartment was used. Even with the frequent opening of the refrigerator, the temperature was never observed to rise above 48° F.

The concentrate was diluted and 1 ml. of 1:1000 was inoculated into each of four media: Lindegren's agar, pH 5.8; dextrose tryptone agar, pH 7.4 tryptone glucose extract agar, pH 7.0; and Sabauroud's dextrose agar, pH 6.2. These media were selected for comparative purposes because each industrial laboratory in the Florida citrus producing area prefers at least one of the media for total count determinations. At a later period in the study when puffed cans or swells were found among the specimens stored at 42°F., a 10% sucrose citric acid yeast-extract agar, pH 3.8, was also employed. This medium simulated osmophilic and pH conditions comparable to those found

[1] Agricultural Chemical Research Division Contribution No. 252.

[2] One of the lobartories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture

in the substrate of the puffed cans. Microscope slide checks were made at the time the colonies were counted, tabulations of the results were not made, and only general statements referring to them will be given.

Results

The data from the initial analyses—made before storage of the samples—calculated to a reconstituted juice basis are listed in Table 1. The initial analyses show that the concentrate contained infestations of organisms ranging from moderate to very high in number; microscope slide observations indicate that yeasts constituted the principal contaminant.

Table II gives the results of analyses of samples held in the zero room and Table III of those held at 42° F. The numbers of organisms, when only ten or fewer per ml. of 1:1000 dilution of concentrate survived, were not calculated to the reconstituted basis. Instead they were tabulated as numbers per plate.

One sample that had been stored in the zero room for 195 days, and another for a period of 120 days retained a viable cell count of some significance. These two specimens, Nos. 2 and 10, contained sufficient yeast population to cause spoilage if the storage temperature had been allowed to rise or the concentrate to remain at room temperature for a few hours. Specimen No. 10 retained about 4,000 live cells per ml. of reconstituted juice after a period of 120 days. Sample No. 2 contained a moderately heavy infestation of yeast cells the day it was collected but the number of yeast cells surviving zero room storage after 195 days was about 5,000 per ml. of reconstituted juice. Growth did not appear on plates inoculated with concentrate from sample No. 9 after storage period of 128 days, The remaining samples produced very low counts (reported as numbers per plate). Some of these low count specimens were given a reversed rating when they were first analysed (Table I); one in particular, No. 2, contained a count of 400,000 per ml. of reconstituted juice.

After the storage times listed in Table III, the samples were removed from the refrigerator and plated. The procedure and media were the same as those employed during the initial plating, except for the two samples that showed signs of spoilage.

The container of concentrate, No. 4 (stored at 42°) was a hard swell; the other, No. 11, was badly puffed. In addition to the other media used these two samples were plated on a 10 percent sucrose citric acid yeast-extract medium, pH 3.8. The inoculum was diluted 1:10,000.

FORMULA:

Sucrose	10%
Citric acid	0.5%
Yeast extract	0.5%
Potassium mono basic phosphate	0.001%
Peptone	0.003%
Agar	1.5%
Distilled water	

Inoculations of sample No. 4 produced high counts on dextrose tryptone agar and on tryptone glucose extract agar. The 1 ml. inoculation of 1:10,000 dilution on 10 percent sucrose citric acid yeast-extract agar was seeded too heavily, the colonies were too close together, and were so small that it was impossible to obtain a count (Table II). Inoculations on the other two media produced low counts and were considered insignificant (reported as numbers per plate). Inoculations of specimen No. 11 produced colonies that were comparable in number on each of the five media. Sample No. 10 did not appear puffed when it was removed from the refrigerator for analysis, but it produced plate counts similar in numbers to those found in No. 11. Microscope slide check of the growth from these three samples indicated that yeasts were the principal surviving organism. It was also evident that the yeast cells in two of these samples were capable of growing in 42 percent concentrate at 42°. Three specimens of concentrate contained a moderately high contamination of yeast when they were first prepared, (Nos. 4, 10, 11, Table I). Sample No. 2 which produced a high initial count (TableI) and retained a moderate yeast population after a zero room storage of 195 days (Table II) was not collected in triplicate; therefore, the effect of storage at 42° F. was not noted. The other samples showed considerable decline

TABLE I. ANALYSIS OF FRESHLY PREPARED FROZEN CONCENTRATE. NUMBER OF ORGANISMS PER ml. CALCULATED TO RECONSTITUTED JUICE BASIS.[1] INOCULATIONS: 1 ml./1:1000 OF CONCENTRATE

Sample	Plant	Lindegren's agar	Dextrose tryptone agar	Tryptone glucose extract agar	Sabauroud's agar	Processing date
1	D	7 ppl	4,200	9 ppl	4,280	2/ 1/49
2	E	416,620	4,200	350,000	43,330	2/ 4/49
3	B	79,520	84,290	70,950	63,330	2/ 8/49
4	E	89,520	34,290	63,330	43,090	3/ 8/49
5	G	2,860	3,330	2,380	7ppl	3/11/49
6	H	25,470	31,190	21,660	27,620	3/15/49
7	I	7,860	9,760	6,190	8,090	3/17/49
8	C	15,940	11,910	13,330	17,860	3/18/49
9	L	32,290	35,720	34,570	33,710	3/25/49
10	G	27,140	29,520	25,000	34,290	3/31/49
11	B	55,238	57,620	54,760	50,480	4/ 1/49
12	I	19,760	7,860	7,140	9,050	4/ 8/49
13	E	25,000	sp[2]	sp[2]	41,660	4/22/49

[1] Number per plate is given when organisms surviving were ten or fewer and were not calculated to a reconstituted juice basis.
[2] Spreaders.

TABLE II. CONCENTRATE AFTER STORAGE AT 0° F. NUMBERS OF ORGANISMS PER ml. CALCULATED TO RECONSTITUTED JUICE BASIS. INOCULATIONS: 1 ml./:1,000 OF CONCENTRATE

Sample	Plant	Lindegren's agar	Dextrose tryptone agar	Tryptone glucose agar	Sabauroud's agar	Storage time	Processing date
1	D	0	0	1 ppl[1]	1 ppl	138 days	2/ 1/49
2	E	4,762	4,290	5,952	4,290	195 days	2/ 4/49
3	B	3 ppl	2 ppl	10 molds ppl	2 ppl	191 days	2/ 8/49
4	E	0	3 ppl	3 ppl	3 ppl	143 days	3/ 8/49
5	G	2 ppl	4 ppl	2 ppl	8 ppl	142 days	3/11/49
6	H	7 ppl	6 ppl	4 ppl	6 ppl	136 days	3/15/49
7	I	3 ppl	1 ppl	1 ppl	1 ppl	134 days	3/17/49
8	C	5 ppl	1 ppl	5 ppl	4 ppl	133 days	3/18/49
9	L	0	0	0	0	128 days	3/24/49
10	G	3,571	2,619	4,290	3,095	121 days	3/31/49
11	B	4 ppl	2 ppl	3 ppl	3 ppl	120 days	4/ 1/49
12	I	1 ppl	0	1 ppl	4 ppl	115 days	4/ 8/49
13	E	4 ppl	2 ppl	4 ppl	4 ppl	111 days	4/22/49

[1] Number per plate (ppl).

TABLE III.C CONCENTRATE STORED AT 42° F. NUMBERS OF ORGANISMS CALCULATED TO RECONSTITUTED JUICE BASIS. INOCULATIONS: 1 ml./:1,000 OF CONCENTRATE

Sample[1]	Plant	Lindegren's agar	Dextrose tryptone agar	Tryptone glucose extract agar	Sabauroud's agar	Storage time	Processing date
4	E[2]	5 ppl[3]	26,190	35,714	4 ppl	143 days	3/ 8/49
5	G	1 ppl	0	1 ppl	0	142 days	3/11/49
6	H	Sample lost	.....	.....	.....	.....	3/15/49
7	I	6 ppl	1 ppl	4 ppl	4 ppl	134 days	3/17/49
8	C	1 ppl	1 ppl	3 ppl	5 ppl	133 days	3/18/49
9	L	1 ppl	0	1 ppl	2 ppl	128 days	3/24/49
10	G	5,714	3,309	5,477	8,332	121 days	3/31/49
11	B[4]	7,619	7,619	7,619	5,952	120 days	4/ 1/49
12	I	5 ppl	4 ppl	2 ppl	8 ppl	115 days	4/ 8/49
13	E	6 ppl	2 ppl	5 ppl	6 ppl	111 days	4/22/49

[1] Samples 1, 2, 3 were not collected in triplicate.
[2] Also plated on 10% sucrose acid yeast-extract agar, 1 ml./1:10,000; too many to be counted.
[3] Number per plate.
[4] 8757 per ml. of reconstituted juice on 10% sucrose acid yeast-extract agar.

in viable contamination at 42° (Table III). Yeast was the major microbiological contaminant when the initial analysis was made on these specimens; this was found to be true also of the surviving organisms in the final analysis.

It will be noted that there were marked reductions in the count of micro-organisms at both zero and 42°. Since the action of the microorganisms is vastly different at these two temperatures, direct comparisons of the counts between the two temperatures should not be made. However, the survival of substantial numbers at zero indicates the possibility of fermentation should the sample be transferred to refrigerator or to room temperature.

As the samples were removed from zero and 42° storage, they were reconstituted in accordance with the instructions on the label and

tasted. In every case the flavor was superior in the samples that had been held in zero storage. However, the puffed and swelled containers did not emit the odor of alcoholic fermentation or sourness.

When the samples held at 42° F. were reconstituted, the suspended matter and cloud settled rapidly, leaving a clear layer of juice. This was considered evidence of enzyme action. The clarification and curdling of the suspended matter is unsightly and undesirable. Samples stored at zero did not show this clarification.

The yeasts that caused the spoilage of concentrate at 42° F. have not been studied and identified.

Conclusions

The storage of orange concentrate in the zero room for a period of 198 days does not insure the destruction of spoilage organisms; however it tended to reduce the numbers. Many samples stored at 42° F. showed a decrease in viable count. Certain yeast infestations in concentrate stored at this temperature will grow and produce spoilage. Enzyme activity continued in samples of concentrate stored at 42°. Yeast predominated among the surviving organisms in concentrate stored both in zero room and at 42°.

Proper temperature control is necessary to safeguard the quality of orange concentrate in storage.

DISPOSAL OF CITRUS WASTE WATERS

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Papers relating to the utilization and disposal of citrus wastes have been presented on previous programs of this Society. It is not my intention to repeat or to restate the information which has already been presented. However on the basis of personal experience with several citrus disposal areas, I present certain ideas which may be of interest and value to you, if you make use of lagoons or pits for the disposal of strong citrus wastes.

The composition of citrus wastes is well known to you—also the fact that the wastes, especially those from citrus feed mills, are rich in fermentable material. One of the best—certainly the most widely quoted—reports on the composition of citrus wastes was written by Nolte, von Loesecke and Pulley. It was entitled "Feed Yeast and Industrial Alcohol from Citrus Waste Press Juices," published in Industrial and Engineering Chemistry, page 670, June 1942.

Press water from citrus feed mills contains about 7% sugar, in addition to small amounts of citric acid, pectinous material, protein, etc. Some of our citrus feed mills discard upwards of 5,000 gallons of press water per hour. In other words they throw out over one and a half tons of mixed sugars every hour. For every thousand boxes of oranges used in a cannery, about 1600 lbs. of sugar is discarded with the peel. This fermentable material is rapidly acted upon by yeasts and bacteria, providing there is an ample supply of oxygen. Hence, if the wastes are added to lakes or streams, available oxygen in the lakes or streams is used by the wastes, reducing available oxygen to the point where fish and other life suffocates. In other words, the B. O. D. of the wastes is too high to permit their disposal into lakes and streams.

Dr. Robert S. Ingols emphasized this point very well in a paper he presented to this Society in 1944. Dr. Ingols stated that the solids in the waste press water from one cannery was equivalent to the solids in sewage from a city of about half a million people! Adequate sewage treatment for an inland city of this size would cost at least two million dollars, for equipment alone.

I am firmly convinced that a profitable utilization of these feed mill waste waters is possible. However, if a cannery must throw away its hourly tonnage of sugar, it must be

done in such a manner as not to create a nuisance.

Waste waters soak through the surface sands rather readily until they reach the red clay hard pan which seems prevalent in the central Florida area. Wastes then flow along the clay until a low area is reached. The surface of the hard pan does not necessarily duplicate or parallel the visible surface of the top of the sand. An area may seem to slope off in a certain direction and be ideal for the location of disposal pits. The underlying clay, however, may slope in a different direction.

Under one set of citrus disposal pits a clay ridge extended across the entire series of primary pits, so that approximately one third of the absorbed waste water flowed back in a direction opposite to that intended. At another location the clay under about one quarter of the area not only sloped the wrong way, but led to a large saucer, or well, in which untold thousands of gallons of citrus wastes collected, anerobically fermented, and then seeped out, polluting the atmosphere. The top of this cess pool was about nine feet below the surface of the ground; its depth and extent were undeterminable.

Therefore, Rule No. 1 in laying out disposal pits should be: "Locate the Clay Surfaces." Using a two inch auger, a double row of holes should be drilled around the edge of the area. The rows should be at least 75 feet apart. The holes should extend downward just to the clay, which is readily recognized when it is reached. One or more additional rows should cross the area. Depth from sand surface to clay, and from sand surface an imaginary horizontal extending from the highest point of the area should be measured. The sand-to-horizontal distances will necessitate the use of a surveyor's level. From this data surface and clay level contours can be drawn. Then, and only then, can pits be staked out. It costs very little to secure this information. It costs considerably more to blindly construct disposal pits and find foul smelling liquid out-cropping in unexpected places.

If new pits are to be laid out on an area which has previously been used for disposal, the old layer of solids must first be removed. The old layer of solids will act as a seal, preventing any seepage of liquid into the sand. It consists mostly of protein and carbohydrate; it can be used as fertilizer, or, when dry, can be raked into piles and burned.

Various types of lagoons, or pits, are described in the literature. Also, various methods of operation are presented. Citrus wastes differ from most cannery wastes in that they are comparatively low in suspended solids, and rather high in soluble solids, particularly sugar. Methods in successful use in vegetable canneries are not so satisfactory with citrus wastes. We have a ton and a half or more of sugar to dispose of every hour. The cheapest way to dispose of this tonnage of sugar is to encourage yeast, already abundant in the waste, as it leaves the cannery, to convert the sugar to carbon dioxide and water, utilizing atmospheric oxygen. Large, shallow pools, or pits, in which the liquid is never more than six inches deep, will permit maximum exposure to air. As the waste water is pumped into such a pit, spraying or splashing will materially aid the aeration. Vigorous bubbling in the pit will indicate a healthy yeast activity. Within forty-eight hours practically all sugar will have fermented, and it is not necessary to supplement natural aeration with nitrate. It requires about two tons or more of nitrate to supply oxygen enough for each ton of sugar, so the cost is prohibitive, as well as useless.

However, a considerable quantity of water will seep down through the sand, carrying unfermented sugar with it. This sugar will be subject to anaerobic fermentation underground, and may produce offensive smelling decomposition products which will seep to the surface of low areas . Such foul smelling areas can be treated with dry hydrated lime, which will immediately neutralize the organic acids responsible for odor. However, if the source of contamination is large and extensive, so that foul odors recur almost daily, then a heavy application of nitrate of soda will be beneficial.

Various suggestions have been made that foul areas be treated with creosote, or other agents to kill the micro-organisms which are producing the odor. I prefer the viewpoint that partly decomposed organic matter is the source of the odor—hence, do not eliminate the only possible control measure we have by killing the beneficial microorganisms. By adding nitrate to help the organisms, and lime to counteract odors as they are formed, the organic matter will completely decompose and eventually disappear. Odor from soggy ground areas can be controlled by the application of lime alone, or by lime and nitrate.

Odorous pools, either underground or on the surface, present a research problem. No sugar remains in the liquid and application of lime offers help only if the pH is carefully controlled. Liming to a pH of 7.5 or higher, results in a different, but still unpleasant, "burned" odor. This odor may come from nitrogen material, and it should be investigated. Odorous water of this type is very dark in color and shows no inclination to ferment. It is high in bacteria, and low in yeast. It has a solids content of less than half of one percent.

Another research problem involves the study of a satisfactory biologically balanced pool, with sufficient plant and animal life to maintain it in an odorless condition.

FROZEN CONCENTRATED ORANGE JUICE - PAST, PRESENT AND FUTURE

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It is difficult to point to any food industry that has expanded as rapidly as that concerned with the manufacture of frozen concentrated orange juice. Very few food products have met with consumer acceptance so quickly. Praise for this product has been spread across the country by articles in all types of publications from the "Reader's Digest" to "The Wall Street Journal." A recent report[13] indicated that the product has become the largest selling item in the frozen food field and accounts for approximately 30 percent of total frozen food volume. When 17 distributors in 13 large cities throughout the country reported[14] on their best selling items for August, 1949, orange juice concentrate received all first place votes except one, which went to frozen peas. Among frozen fruits orange concentrate was first and strawberries second. This success of frozen concentrated orange juice can be largely attributed to the fact that it is a high quality, standardized product, retaining the flavor and nutritional characteristics of fresh fruit. Also from the consumer's point of view it is convenient to handle and serve and will soon be available on a year round basis. The following approximate production figures, which are based on statistics from the Florida Citrus Commission and the Florida Canners' Association, indicate the rapid growth of the frozen concentrate industry:

1945-46	225,000 gallons
1946-47	560,000 gallons
1947-48	1,935,000 gallons
1948-49	9,931,000 gallons

One million gallons of frozen concentrate is sufficient to fill approximately 21 million six-ounce cans, which are the familiar consumer package units. The following figures indicate the number of oranges needed to supply the juice necessary for one six-ounce can of concentrate:

Number of oranges (size 200) of different solids content to yield one 6 oz. can of 42° Brix concentrate based on yield of 4¾ gal./90 lb. box:

°Brix	8	9	10	11	12	13	14
Number of Oranges	11.9	10.6	9.5	8.6	7.8	7.2	6.7

The development and success of frozen con-

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centrated orange juice has been brought about by the initiative, research, salesmanship, and hard work of many people and companies. The preparation of a concentrated orange juice product requires the removal of water. Methods for the removal of this water by crystallization and evaporation have been the subject of research for many years, as adequately reported by Moore, *et al*[3].

Stahl[8] described the characteristics of frozen concentrated citrus juices which had been concentrated by freezing at the University of Florida in 1942. Samples of 48° Brix frozen Valencia orange concentrate, that had been in frozen storage for 22 months, showed no changes in acidity, taste or color, and could not be distinguished from fresh juice. The retention of volatile flavoring constituents and the absence of off-flavors, that could be caused by heating, were noted as advantages of this freezing method over evaporation processes of concentration that were then available.

Many difficulties, both technical and economic, encountered in the concentration of orange juice by freezing and the subsequent separation of ice crystals, have resulted in the commercial application of this method only to a limited extent. One commercial plant in Florida produced a 3-fold frozen concentrated orange juice by this method during the 1948-49 season.

During the 1943-44 season, research personnel of the Florida Citrus Commission working in cooperation with the U. S. D. A. Citrus Products Station, Winter Haven, Florida, investigated, as reported by MacDowell[8] and by the U. S. Bureau of Agricultural and Industrial Chemistry[8 9 10], a type of frozen orange juice concentrate in which the juice, concentrated 5- to 8-fold by vacuum evaporation, was diluted with freshly extracted juice to obtain a 3- or 4-fold concentrate, which was then frozen. A patent covering this process, based on work of the 1943-44 and 1944-45 seasons was applied for in 1945, granted in 1948 to MacDowell, Moore, and Atkins[4] and assigned to the United States of America as represented by the Secretary of Agriculture. All major concentrate manufacturers are now using this basic process. Frozen citrus concentrate, as known today, is an excellent example of where money spent for research has paid immediate dividends, which in a very few years have dwarfed the initial investment in research.

As an indication of the nationwide publicity and recognition given to the Florida frozen concentrate industry, mention is made of the 1949 Food Industries Award[11] to the Florida Citrus Canners Cooperative, Lake Wales, Florida, for outstanding technological achievement in food processing. Information in reference to the development and operation of pilot or commercial plants for the manufacture of frozen citrus concentrates at Plymouth, Lake Wales, Highland City and Florence Villa, Florida, has been presented in various publications.[1 12]

Concerning the present situation in this rapidly expanding field, we find that ten plants are ready to begin operation for the 1949-50 season and that five plants are in various stages of completion. Since mid-season and late-season oranges are preferred for concentrate manufacture, processing usually begins about the first of December. It is estimated that the final production capacity of all Florida processors for the 1949-50 season will be approximately thirty million gallons of frozen citrus concentrate during a processing season of 140 days of 20 hours each, or a total of 2800 hours. This capacity indicates that the equipment in all of these plants will be evaporating water from juice (12° Brix) at the rate of 31,800 gallons per hour. Thirty million gallons of citrus concentrate will be enough to supply each of the forty-two million families in the country with approximately 15 six-ounce cans. During the coming season all of this capacity may not be used, but it has been estimated that from 20 to 25 million gallons of frozen concentrate may be produced. Since slightly more than one gallon of concentrate is secured from each box of oranges, the estimated production of 20-25 million gallons of concentrate during the coming season will require approximately 20

million boxes of fruit, or about 30 percent of the estimated orange crop. This volume of oranges, destined for the frozen concentrate industry during this season, is approximately five times the 4,126,598 boxes of oranges, reported by Willson[7] as being used for all types of canned orange products during the 1941-42 season.

The process used today for the commercial manufacture of frozen citrus concentrate is based primarily on three operations. The first of these is the removal of water from the juice by evaporation under vacuum at temperatures sufficiently low to avoid impairment of the natural flavor of the juice. The second step is the blending of the concentrated juice with a quantity of freshly extracted juice, in order to give the finished product sufficient fresh fruit aroma and flavor. The final operation is the preservation of the product by freezing. A brief description of the process used today for the manufacture of frozen citrus concentrate follows. Fresh fruit is thoroughly washed, and the juice is extracted by various types of juice presses, that have been standard in citrus canning plants for years. After extraction the juice is placed in various types of evaporators, where it is concentrated by evaporation of the water under vacuum at temperatures of 60°-80°F. until a product of 55°-58° Brix is secured. This concentrated juice is then blended in refrigerated tanks with sufficient fresh juice so that the finished, standardized product will have a total solids content at 41.5°-43.5° Brix. The amount of fresh juice added to the original concentrate amounts to approximately 10 percent of the total fresh juice required to prepare the finished product. Compared to the volume of the 55° Brix concentrate used, the fresh juice added amounts to approximately 50 percent. The finished, chilled concentrate is pumped from the blending tanks to a continuous freezing unit where the product is slush frozen, and subsequently filled into six-ounce cans, that are vacuum closed by either steam closure or mechanical vacuum. Immediately after closing, the cans are passed through a freezing tunnel, where the entire contents are quick-frozen, after which the cans are packed in cartons and stored at temperatures of 0°F. or lower. This product must be maintained at these cold temperatures, because it is not pasteurized and storage at higher temperatures will result in deterioration and fermentation.

The 42° Brix frozen orange concentrate is often referred to as a 4-fold product, which means that the solids content is four times that of 12° Brix fresh juice. Therefore, when the consumer uses this product, three cans of water are added to each can of concentrate; and when this is done, the solids content of the reconstituted juice will be approximately 12° Brix.

Looking toward the future, one question that will have to be answered is what effect the consumption of frozen citrus concentrate will have upon the consumption of fresh or canned citrus products. Indications are that the sale of the concentrate will cause a decrease in the consumption of both fresh fruit and canned products. However, there are also indications that a large proportion of the concentrate actually represents new and increased consumption. The Florida Citrus Commission is now conducting consumer surveys in an attempt to secure definite answers to this question.

A recent report[15] stated that in April, 79 percent of the retail food stores in the United States were handling fresh oranges, 90.8 percent were handling canned orange juice and only 16.7 percent of the stores handled frozen orange juice concentrate. It can be anticipated that, as facilities for handling this product increase, a greater number of retail stores will make it available to consumers. Competition between frozen concentrates and canned pasteurized citrus juices should challenge the canners to improve by every means available the quality of their products.

In an industry as large as the concentrate industry problems will arise in the future concerning the manufacture, transportation and preservation of the product. In order to help solve some of these problems, processing equipment has been installed at the Citrus Experiment Station at Lake Alfred for the

manufacture of frozen citrus concentrates. Packs of orange, grapefruit and tangerine were processed in the 1948-49 season. A new evaporator has been designed and is being installed at the Station to be used during the 1949-50 season. This evaporator is a single-effect, two stage recompression type, having a capacity of approximately 20 gallons per hour of 42° Brix concentrate, and is similar to some of the commercial installations.

How will the concentrate industry affect the grower? With over 50 percent of the total citrus fruit produced in Florida being processed, the grower should give more consideration to the production of the type of fruit best suited for processing. In growing fruit for the fresh fruit market, both the external appearance and the internal quality are of prime importance. Concerning fruit that is to be processed, internal quality is of utmost importance, while external appearance is of little significance. Therefore, certain production practices which are necessary to insure good external appearance may not be necessary if the fruit is to be processed.

The manufacturers of frozen citrus concentrate desire fruit that will give high juice yields. Desirable qualities of the juice are high solids content, proper Brix/acid ratio, good color and flavor. High-solids juice is desired for two reasons. First, more 42° Brix concentrate can be secured from a box or a ton of high-solids fruit than from a box or ton of low-solids fruit as is illustrated by the following calculations:

Number of boxes of oranges of different solids content to yield 100 gallons of 42° Brix concentrate based on yield of 4¾ gal./90 lb. box.

°Brix	8	9	10	11	12	13	14
Number of Boxes	127	113	101	92	84	77	71

Number of tons of oranges of different solids content to yield 10,000 gallons of 42° Brix concentrate based on 4¾ gal./90 lb. box equal 105.6 gal./ton (2,000 lbs.):

°Brix	8	9	10	11	12	13	14
Number of Tons	573	508	455	412	376	346	320

Secondly, processors have to remove more water from low-solids juice than from high-solids juice in order to produce the same quantity of 42° Brix concentrate. The evaporation of water during processing requires time and is expensive. Since more water has to be evaporated from low-solids juice than from high-solids juice, the processing cost to the manufacturer will be greater when low-solids juice is used. The following calculations indicate how the hourly yield of concentrate varies as the solids content of the juice used varies from 8° to 14° Brix:

Production of 42° Brix concentrate in relation to the solids content of the fresh juice. Based on rate of evaporation of water at 10,000 lb./hr.:

°Brix	8	9	10	11	12	13	14
Concentrate—gal. per hour	238	275	316	358	404	453	504

Since juice of high-solids content is very desirable, indications are that in the future processors may pay a premium for fruit of high-solids content. Offering a premium price to the grower for high quality fruit should cause him to expend more effort in growing fruit of better internal quality.

The demand for fruit by the frozen concentrate industry has definitely helped to solve the surplus problem in citrus fruits, which existed several years ago. A freeze in Texas and production problems in California have temporary effects on the Florida citrus situation, but the use of huge volumes of fruit by the concentrate industry should in the future be a stabilizing factor.

In order that a successful industry may continue to have a bright future, manufacturers of frozen citrus concentrate should strive to keep the quality of the product at the high level that has been maintained in the past and also continue to educate wholesalers, retailers and consumers in the proper handling of this excellent product.

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ORNAMENTAL SECTION

ROSE CULTURE IN FLORIDA

C. H. Blackmon

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Gainesville

Roses are grown in all parts of Florida in home gardens and, in some areas, for commercial cut flower production. However, in this paper the culture of roses on the home grounds will be the only phase discussed. They are not so difficult to grow if suitable precautions are taken in regard to the location of the garden, soil preparation, selection of varieties and planting stock.

The rose garden should be located so that the plants will receive adequate sunlight and where roots from trees and large shrubs will not rob the soil of plant food and moisture. In preparing the rosebed, the soil should be spaded to a depth of six to eight inches at least two weeks prior to planting, after making a liberal application of superphosphate and potash spread broadcast over the surface, together with some good organic material. The fertilizer materials should be applied at the rate of not less than 8 pounds of superphosphate and four pounds of suphate of potash for each 100 square feet of the garden but, in many instances, a greater amount will give better results. If separate materials are not available, 0-14-10 will be satisfactory, applied at about 20 pounds per 100 sq. ft.

The plants can be set any time during the dormant season, but generally best results will be obtained by planting during November and December, using a handful of bone meal mixed with the soil in each hole. The soil is then made firm and watered thoroughly. The entire garden should be covered to a depth of six to eight inches with an organic mulch such as oak leaves or some other good material which may be available. This mulch is left in place to conserve moisture and should not be disturbed until fall or winter when it can be spaded into the soil.

It should be pointed out that only strong, two-year, Number one plants should be used, if the most satisfactory results are to be obtained with newly planted roses. The plants can be set either 18 or 24 inches apart each way in the bed, and they should be unpacked and transplanted immediately upon arrival from the nursey but, if there is a delay, they should be placed in a trench and the roots completely covered with soil and thoroughly watered. After setting and before the holes are completely filled, flood the entire garden with water so as to settle the soil thoroughly about the roots.

The plants give best results when pruned to about 12-inch stems at the time they are transplanted. Subsequently, they are given

very little pruning during the first year except that provided in cutting the flowers. If multiple or lateral buds are developed on the stem, these can be reduced to one by disbudding when the buds first appear.

Many rose growers in Florida have adopted the plan of transplanting new stock each year with good results in many locations. With this method the plants must be kept in a vigorous, thrifty condition at all times so as to maintain maximum flower production throughout the growing season. Where roses are grown as annuals, blooms can be left on the plants, or they may be cut regularly for decorating the home, whichever is the most desirable. At the end of the blooming season the plants are then removed and the soil made ready for setting the new stock during November and December. When roses are grown in this manner it is possible to increase the variety list greatly, as many can be grown for one blooming season that would not be satisfactory over a period of several years.

Fertilization during the growing season should consist of some good nitrogenous materials applied about three times, generally, in April, June and August. The dates will vary somewhat, depending on the stage of growth, as an effort should be made to make the applications when the plants are in heavy flower production. These materials will give satisfactory results if they are applied on the mulch and allowed to be gradually washed into the soil by rains and irrigation. If superphosphate and sulphate of potash were not applied in preparing the bed for planting, then apply any good complete fertilizer in late February or early March, using about ½ pound per plant of a mixture containing about 4 to 6 percent nitrogen, 8 to 10 percent phosphoric acid and 6 to 8 percent potash. This should prove adequate at this time for both the new garden and the permanent planting.

The garden should be watered frequently during the growing season when there is not sufficient rainfall to meet the requirements of the plants. Flooding the soil is generally best but, where this is impossible, an ordinary whirling type of lawn sprinkler can be used for irrigation, turning on the water each morning as required after the blooms are cut.

There are hundreds of varieties listed in catalogs from which selections can be made that produce blooms of different colors and various bud conformations. Those who care to test new introductions can plant a few each year and compare the results with the behavior of standard kinds being grown. In this way valuable information will be obtained that will be helpful in making selections for an individual garden in future plantings, and data will also be accumulated for the benefit of all rose growers. For those who wish to leave the experimental work to others, it is recommended that only a few well chosen kinds be grown, including enough plants of a particular variety to supply blooms in sufficient quantities to make an adequate showing of cut flowers for decorations in the home.

There are several varieties which can be had that will give a range of colors and succession of blooms that should please most amateur growers. Such a list would certainly include the Radiance types, Editor McFarland, Etoile de Hollande, Talisman, Betty Uprichard, Lady Hillingdon, Luxembourg, Antoine Rivoire, K. A. Viktoria, and many would add Frau Karl Druschki, Chas. K. Douglas, President Herbert Hoover, Golden Ophelia, Columbia, Dainty Bess and others not mentioned here, including the Louis Philippe as a bedding rose.

There are several of the old Tea roses which merit attention as garden varieties. Many of these are vigorous growers, highly resistant to diseases, and will supply an abundance of bloom for several years. They can be grown satisfactorily over a large part of the state with average care. Marie van Houtte, Baronesse Henrietta Snoy, Maman Cochet, Wm. R. Smith, Freiherr von Marschall, and some others are varieties of Tea roses which may be obtained for planting.

There are certain insects and diseases that will require control measures to insure best results with roses. For full information on these pests please write to the Florida Agricultural Experiment Station at Gainesville.

In the growing of roses, one should bear in

mind that the plants must continue in a thrifty growing condition in order to force a maximum bloom production. To do this, it is not absolutely necessary to build a specially prepared bed unless the soil and location are such that they are entirely unsuited to the growing of roses. With strong vigorous stock in fresh condition, and the needed plant foods and moisture supplied so that adequate growth will be made, plants of suitable varieties will prove satisfactory in giving a heavy bloom production.

MUSHROOM ROOT ROT IN FLORIDA

ERDMAN WEST

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Mushroom root rot is a disease of woody plants that causes the death of many kinds of ornamentals and crops in Florida. It is especially painful to the home owner because it frequently causes the loss of key specimens in carefully landscaped plantings. Peach, tung and guava growers have incurred severe losses in their groves from this cause. It is the most serious disease of woody plants in the state.

Mushroom root rot in Florida is caused by *Clitocybe tabescens* (Scop. ex. F.) Bres. a native fungus belonging to the group generally known as mushrooms. It has been found in other states but in the northeastern and western states, *Armillaria mellea* Vahl ex Fr., a similar organism, is more prevalent. The latter is comparatively rare in Florida. The two organisms may be distinguished by certain vegetative and fruiting characters. Armillaria produces rhizomorphs, the mycelium is phosphorescent and the mushrooms have an annulus on the stalk. Clitocybe produces no rhizomorphs, is not luminescent and bears no annulus on the stalks of the fruiting bodies.

Mushroom root rot has been found on native Florida plants under natural or uncultivated conditions. Some of our native oaks, especially turkey oak (*Quercus laevis*) and laurel oak (*Q. laurifolia*) are frequently found in nature bearing sporophores of the fungus. These native trees are resistant to the disease and live long after the root system has been invaded. It is only after they have been injured by some other agent that they succumb to the combined effects of the fungus infection and the injury. Such factors include lightning, fire, wind-storms and insect or other animal damage. Such infected trees thus maintain a continuous supply of inoculum and are a constant menace to nearby trees.

Theoretically infection can occur in either one of two ways but only one has been demonstrated experimentally. Roots of a healthy plant may grow through the soil until they come in contact with an infected root of a diseased tree. The fungus can spread from the diseased root to the healthy root. This method has been proved with tung in Louisiana and citrus in Florida. Since the fungus can persist in several diseased roots for some time, the infective pieces are not necessarily still attached to the diseased tree. This fact explains why newly cleared oak land may show a relatively high infection of mushroom root rot when planted to a susceptible crop. The fragments of diseased oak roots left in the soil after clearing operations furnish abundant inoculum to infect any susceptible plant set in the soil. By this method infection occurs only in the vicinity of the original diseased tree and spread of the disease is relatively slow.

The other method of spread is by spores. Thousands of spores are produced on the under sides of the mushrooms or fruiting bodies. These spores are minute and may be carried for long distances by air currents. If one of these spores should fall in a favorable situation on a susceptible tree, it is conceivable that a new infection could start at that point. Since the spores are delicate and probably short lived, the chances of all these favorable factors for infection occurring at the same time are extremely small. The few infections that do result in this manner are likely to be

remote from the original infection, resulting in the dissemination of the disease over a wide area.

After infection has occurred by either means, the progress of the disease and the development of the fungus proceeds in a similar manner. From the point of infection the fungous threads penetrate the cambium layer between the bark and the wood. If the tree has no bark, as in the case of a monocot the fungus grows directly through the pithy tissues. As the affected area is killed, the fungus spreads along the roots to the crown of the plant. After this has been reached, the fungus gradually grows around the stem and outward along any lateral roots that may be reached. Soon after the crown or main stem is encircled, the top of the plant wilts and dies. Up to this stage, there is little or no evidence of disease on the plant attacked. After the plant has been dead sometime, usually just after the end of the next rainy season, clusters of fruiting bodies of the fungus appear at the base of the trunk or stem and sometimes along the larger roots where these are close to the surface of the soil. These clusters may contain a 100 or more mushrooms but usually there are not more than 25 to 50. The caps of these umbrella-shaped mushrooms are 3 inches or less across, pale brown or tan in color and are borne on crooked stalks 2 to 6 inches long. The underside of the caps are lined with gills or narrow plates set on edge, radiating from the central stalk.

Usually the only symptoms of the disease are the sudden wilting and dying of the foliage of the affected plant. Some species including casuarina and citrus show stunting or shortening of the new twigs or growth. Since fruiting bodies of the fungus are seldom if ever present at this stage, we look for other signs by which to diagnose the cause of the trouble in the early stages. The most constant of these is the white layer of fungus growth between the bark and the wood in the recently killed parts of the plant. On thin-barked species like azalea, the layer is very thin and difficult to find. On other plants such as guava or loquat, the white layer is usually conspicuous if the bark is carefully removed.

The host range of this fungus has proved very wide in Florida and new species are frequently being added to the host list. Over 200 native and introduced plants are now reported to be attacked by this disease. Such crop plants as peach, tung, and guava are known to be quite susceptible. The list of ornamentals is long and I am not going to mention but a few as Dr. Rhoads, a plant pathologist formerly with the Experiment Station is preparing a complete list for publication. Among the known susceptible plants are azaleas, roses, jasminums, phoenix palms, dogwoods, royal poincianas, bananas, wistarias and aborvitaes. Many casuarinas have been killed by this fungus and even native sand pines succumb occasionally. So many different kinds of plants have become infected that we have almost reached the point of wondering whether any woody plant is immune. However, some species appear more or less tolerant of the disease, that is they may contract the disease but not succumb to it for a considerable length of time. Citrus comes in this category for although they do not thrive or produce good crops of fruit, neither do they die. The native oaks mentioned earlier also show the same tolerance.

Control measures for mushroom root rot have not proved satisfactory. By the time unmistakable symptoms have developed, the plant is dead or nearly so. Some measure of success has been obtained by drastic surgery in the case of plants that grow in clumps. For instance parts of infected azaleas can be saved if the diseased portion is isolated at one side of a crown bearing several stems. If all of the infected portion can be pruned out and the remaining healthy portion set in clean soil, success may be expected. Plants growing from a single stem can not be treated in this manner. No fungicides as sprays or soil treatments are likely to be effective.

Replacing plants killed by mushroom root rot is attended by some risk unless certain precautions are observed. If it is wished to set another woody plant of the same or differ-

ent species in the same place as one killed by this disease, all roots should be removed carefully from the soil before replanting. If there are no other plants adjoining the spot, the soil may be sterilized by drenching it with formalin solution, 1 part of commercial formalin to 50 parts of water. The fumes will diffuse for several feet in all directions in the soil and other plants nearby may be injured. The formalin treatment is seldom feasible in landscaped plantings but in groves it is very useful. One other method may be used. The soil in the affected area may be removed and replaced with fresh soil obtained in an area in which no woody plants have been growing for at least 5 years. This is the easiest and safest procedure in home plantings.

Considering all of the characteristics of this disease and its causal agent, mushroom root rot is the most serious disease affecting woody plants in Florida and the most difficult to combat.

RESEARCH ON ORNAMENTALS AT THE FLORIDA AGRICULTURAL EXPERIMENT STATION

R. J. WILMOT

Florida Agricultural Experiment Station

Gainesville

This discussion will be limited to the work at the Main Station at Gainesville but it should be remembered that there is considerable work being carried on at Branch Stations and Laboratories located at Leesburg, Sanford, Belle Glade, Bradenton, Homestead and Lake Alfred that has to do with the growing of ornamentals.

It should be pointed out that the work at Gainesville is not limited to the Department of Horticulture but various aspects are carried on by other Departments.

Press Bulletin 10 by H. H. Hume entitled "Plants Affected by Root Knot," published in 1901, is probably the first publication on ornamental plants by the Experiment Station. Although Dr. Hume served in an administrative capacity for the past 18 years he has continued to publish works on various ornamentals such as azaleas, camellias, holly and zephyranthes.

The late Prof. J. R. Watson of the Department of Entomology probably published more popular articles on insects of ornamentals than any other worker in the field. This Department has research work in progress on root-knot and the control of insects on ornamentals. Dr. L. C. Kuitert gave a paper last year to this Section and has another for this year. Dr. A. N. Tissot has published on the aphids that attack ornamentals.

The Department of Plant Pathology, of which Dr. W. B. Tisdale is head, has projects on diseases of ornamentals that have either been completed or are still in progress. Many years ago J. L. Seal worked on Phytophora bud rot of coconut palms jointly for the State Plant Board and the Department and Mr. Erdman West on Rhizoctonia damp off of Boston Ferns. Dr. Tisdale proved that Pythium root rot was responsible for the large losses of Chinese Evergreen by some growers and made recommendations for its control. Mr. West has spoken to you on Witches broom of oleander and has worked on Powdery Mildew of crape myrtle, Cercospora leaf spot of pittosporum, *Sclerotium Rolfsii* attacking annuals, and has a project on die-back of camellias. Dr. H. N. Miller is working on diseases of pot plants. Some of this work dates back 25 years. The book Native Trees of Florida was written jointly by Miss Arnold and Mr. West. Plants sent in for identification are handled in this department.

Samples taken from soil in which ornamentals are grown is given to the Soils Department for analysis and they make recommendations as to treatment necessary to modify it for the best growth of the plant involved. Dr. Nathan Gammon is a cooperator in the camellia project of the Department of Horticulture. The late Dr. R. M. Barnett collaborated

with Harold Mowry on Press Bulletin 496, "Soils for Azaleas."

The work of the Department of Horticulture must start with the work of Harold Mowry, Director of the Experiment Station. While he was in the Department he published the following bulletins: "Hedges for Florida," "Ornamental Vines," "Native and Exotic Palms of Florida," "Ornamental Trees," "Miscellaneous Tropical and Sub-Tropical Fruits," many of which are ornamentals. "Bulbs in Florida," "Propagating and Transplanting Palms." He studied the nitrogen fixing nodulation of Australian pines.

Mr. G. H. Blackmon, head of the Department, although his specialty has been pecans, has contributed to our knowledge of ornamentals and in 1939 collaborated with the late W. L. Floyd and J. V. Watkins on Bulletin 102, "Roses for Florida."

Mr. R. D. Dickey has studied the mineral deficiency diseases of many of the ornamentals and has published on the manganese deficiency of the plumy coconut palm and several other woody ornamental plants. Much of his early work was done on narcissus production and he is joint author of "Azalea Culture in Florida" and "Ornamental Hedges for Florida," and is currently revising the vine bulletin and writing one on hibiscus culture. He is studying the effect of cold storage treatment of tulip bulbs on their subsequent flowering.

For several years the writer worked on the effect of methyl bromide and hydrocyanic gas fumigation of bulbs and ornamental plants. It was found that fumigation increased the production of bulbs of Soleil d'Or and other varieties but did not significantly affect flowering. It was found that many plants withstood fumigation without ill effects but others were severely damaged under the same conditions.

An experiment was started a few years ago to try to develop a fungicidal dip that would prevent the damp-off of cuttings in the cutting bed. Various fungicides were used with and without Hormodin No. 2 and with and without Goodrite Latex with appropriate checks on camellias and azaleas particularly and subtropical ornamentals with the result that it has been found that none of the fungicides used have any residual effect but that in some cases there is an actual hormone effect from the fungicide that may or may not be greater when combined with Hormodin No. 2. Copper A was decidedly toxic to azaleas when used as above.

A camellia varietal classification project was started in 1939 and since then the collection has grown to more than 1800 acquisitions including plants of varieties and species from all camellia growing areas in the United States, Australia, England, and Hong Kong.

Cultural phases include the use of acid and neutral fertilizers, a test of nine different mulches and the effect of vermiculite and peat as soil amendments. The use of a standard acid base fertilizer has held the plots where it was applied to 1pH lower than the plots where the neutral fertilizer has been used. Considerable organic mulch has been used on all plots. It was found that both vermiculite and peat increased the exchange capacity of the soil and increased the moisture holding capacity. The amount of potash in the vermiculite plots was increased significantly while the phosphorus was consistently low. At the end of one year there was no significant effect on the growth of the plants. An experiment was set up last spring using pine sawdust, pine bark, pine needles, cypress sawdust, oak leaves, peanut hulls, tung hulls, moss gin trash, peat, and a check. A similar test using the same materials was also set up with Formosa azaleas.

At the time the camellia collection was begun two varietal bibliographies were started, one from the literature and one from nursery catalogs. The literature has been searched back into the early 1700's and nursery catalogs back to 1820 have been examined. With this background it was soon found, when the plants began to flower, that many varieties under old names did not meet the descriptions and that some varieties under new names met old descriptions under old names and that many varieties introduced from Japan under Japanese names have been renamed in this country and in Europe. To date, the synonymy of about 100 varieties has been found

and published. Outstanding among these is C. M. Hovey, which was common in the trade as a variegated form of Mathotiana. The true C. M. Hovey was found in the trade as Col. Firey and Wm. S. Hastie (Mississippi) or, as it was commonly known, Mississippi Hastie. The variety sold extensively as Fanny Bolis was found to be imported from France under the name Latifolia, although the French catalog gave a different description for Latifolia.

Species added to the collection as a basis for a future breeding program are *C. saluenensis, C. reticulata, C. cuspidata, C. maliflora, C. vernalis, C. oleifera,* what may be *C. heimalis, C. hongkongensis,* and hybrids *C. japonica* x *C. saluenensis,* and *C. saluenensis* x *C. cuspidata. Tutcheria spectabilis* and *Gordonia anomala,* close relatives of the camellia, have also been introduced.

EVERGREEN TREES FOR STREET PLANTING IN WARM REGIONS

EDWIN A. MENNINGER

"The Flowering Tree Man

Stuart, Florida

South Florida cities are confronted constantly with the question of what trees to plant along their streets and in parkways. The problem is somewhat different from that faced by more northerly municipalities[1] for several reasons:

First, the trees need to be evergreen, because with a complete absence of snow and practically no cold weather at all, trees that are bare of leaves in winter (the tourist season) look out of place.

Second, trees that are to be grown in the summer hurricane zone (and that would appear to cover the south half of the State), need to be wind resistant to an unusual degree.

Third, most of Florida's big cities are on the Atlantic Ocean or Gulf of Mexico, which means that street plantings near the water must be done primarily with trees that are not injured by salt spray.

Fourth, they must be trees that have been actually grown experimentally in Florida by pioneer horticulturists because the fact they have been used successfully elsewhere is no assurance that they can contend with the alternate periods of excessive moisture and unusually long dry spells that are encountered over most of South Florida. Introductions to date, numbering into the thousands, have produced relatively few trees that meet all requirements, and therefore much remains to be done. Municipal nurseries can easily propagate most trees of proved merit; the question is what trees shall these be?

* * *

This paper represents a survey in six parts:

(1) A brief examination of the trees now being used generally in the larger cities of South Florida.

(2) A study of the street trees in use in Southern California cities 40 years ago and what changes have been made in the selections to date.

(3) An examination of street trees which are NOT NOW USED IN SOUTH FLORIDA OR SOUTHERN CALIFORNIA FOR THAT PURPOSE, but are thus used in Australia, Singapore and other parts of Malaya, India, Madeira, Canal Zone, British Guiana and Brazil, with more or less success. In its relationship to South Florida plantings, this analysis suggests specifically more than 200 trees that other warm localities are using as street trees and therefore might well be objects of experimental growing in Florida to meet our particular requirements. California (after much discarding of objectionable species) is now using 35 trees that are not being used in Florida; Australia offers 40 more, Malaya 10, India 25, British Guiana 4, Panama Canal Zone 8, and Brazil 80 (to mention only the best).

(4) The author's observations of trees already being grown experimentally in Florida, which in his opinion offer promise of usefulness as street trees for particular situations.

(5) An examination of trees which successfully withstood the 162 mile per hour hurricane winds on the Florida East Coast on August 26, 1949, and showed a minimum of damage.

(6) A list of trees which should not be used in parkway planting, having been found objectionable in one or more respects.

I

Miami's park authorities[2] list the following as best in their experience for street planting:

Swietenia mahagoni—WEST INDIES MAHOGANY
Bucida buceras—OXHORN BUCIDA or "Black Olive"
Tamarindus indica—TAMARIND
Delonix regia—ROYAL POINCIANA
Melaleuca leucadendron—CAJEPUT
Quercus sp.—OAK (Three native evergreen species are used).
Acacia auriculiformis—EARLEAF ACACIA (brittle in storms unless trimmed).

Tampa's park authorities[3] list the following evergreen trees as most successfully used there in street work:

Quercus virginiana—LIVE OAK
Q nigra—WATER OAK
Bauhinia variegata—Usually called "orchid" trees.
Jacaranda acutifolia (partly deciduous)
Acacia auriculiformis—EARLEAF ACACIA
Casuarina equisetifolia—AUSTRALIAN PINE
Melaleuca leucadendron—CAJEPUT

II

The comprehensive outline of shade trees for warmer parts of California which appears in Bailey's "Standard Cyclopedia of Horticulture,"[4] was prepared nearly 40 years ago by Davy & Morrison. The evergreen species listed there, in alphabetical order, are:

Acacia decurrens var. dealbata
Acacia elata
Acacia falcata
Acacia lineata
Acacia Melanoxylon
Acacia neriifolia
Alectryon excelsum
Angophora intermedia
Angophora subvelutina
Arbutus menziesi
Bursaria spinosa
Cinnamomum camphora
Cordyline australis
Cordyline banksi
Cordyline indivisa
Cordyline stricta
Cryptomeria japonica
Eucalyptus amygdalina var. angustifolia
Eucalyptus botryoides
Eucalyptus calophylla
Eucalyptus capitellata
Eucalyptus cornuta
Eucalyptus corymbosa
Eucalyptus diversicolor
Eucalyptus ficifolia
Eucalyptus leucoxylon
Eucalyptus polyanthemos
Eucalyptus rostrata
Eucalyptus rudis
Eucalyptus viminalis
Ficus macrophylla.
Ilex aquifolium
Jacaranda ovalifolia
Ligustrum lucidum
Magnolia grandiflora
Maytemus boaria
Myoporum laetum
Olea europaea
Pittosporum crassifolium
Pittosporum eugenioides
Pittosporum tenuifolium
Quercus suber
Schinus molle
Sterculia diversifolia
Syncarpia laurifolia
Tristania conferta
Umbellularia californica

The amazing thing about that selection of 47 evergreen trees is that 35 of them or 74% are natives of Australia. In the decades which elapsed after that list was prepared, much was learned by experience, and only 9* of the 47 trees on the 1911 list were retained among the 34 evergreen trees (other than palms and conifers) recommended in 1939 by the California Association of Park Administrators[5] as suitable for parkway planting in the southwestern United States. On the 1939 list, 19 trees or 57% are of Australian origin. Here is the revised list:

Acacia baileyana
Acacia dealbata*
Acacia floribunda
Acacia latifolia
Acacia melanoxylon*
(4 species dropped, 3 new ones added, all Australian.)
Arbutus unedo
Blighia sapida
Calodendron capensis
Camphora officinalis*
Casuarina stricta
Ceratonia siliqua
Eucalyptus cornuta*
Eucalyptus cornuta lehmani
Eucalyptus corynocalyx
Eucalyptus ficifolia*
Eucalyptus leucoxylon rosea*
(10 species dropped, 3 new ones added, all Australian.)
Eugenia myrtifolia
Ficus nitida
Grevillea robusta
Hakea laurina
Lagunaria pattersoni
Ligustrum japonicum
Magnolia grandiflora*
Melaleuca leucadendron
Nerium oleander
Pittosporum rhombifolium
Pittosporum undulatum
(3 species dropped, 2 new ones are Australian)
Podocarpus elongatus
Prunus caroliniana
Quercus agrifolia
Quercus virginiana
Schinus molle*
Tricuspidaria dependens
Tristania conferta*

A comparison of those recommendations with a list of the trees actually under cultivation today on the streets of Pasadena[6] shows these changes and additions:

Acacia sp.—8 species planted. Additions are **A. podalyriaefolia—A. pruinosa**
Angophora lanceolata—This "apple gum" has replaced earlier introductions.
Casuarina equisetifolia—Still in use despite objectionable features
Eucalyptus—10 species planted. Additions are **E. citriodora—E. erythronema—E globulus**

Eugenia hookeri—Now used in addition to **E. myrtifolia**
Lithocarpus densiflora
Melaleuca genistifolia—Used in addition to **M. leucadendron**
Melia azaderach
Persea indica
Pistacia chinensis
Podocarpus macrophylla—Used in addition to Japanese species.
Prunus integrifolia—Catalina native used in addition to eastern species.
Quercus englemanni—Pasadena native species.
Sterculia acerifolia
Sterculia platanifolia—Two Australian species added to previous.
Ulmus parvifolia sempervirens.

In the city of Los Angeles[7], the following trees are in use as parkway trees, in addition to those cultivated in Pasadena:

Callistemon viminalis
Cornus capitata
Ficus australis
Ficus rubiginosa
Melaleuca styphelioides
Hymenosporum flavum
Pittosporum eriocarpum
Vitex lucens

A report from the city of San Diego[8] shows almost identically the same list.

III

California's strong dependence on trees from Australia suggests detailed examination of the lists of parkway trees in use in the larger cities of that continent. Lord's splendid new volume[9] "Shrubs and Trees for Australian Gardens" names 40 species of evergreen trees, in addition to those now or previously used in California, which have proved meritorious in street plantings. Here they are:

HALF-HARDY	MORE TENDER
Small—to 15 ft.	
Angophora cordifolia	Callistemon citrinus
Hakea saligna	Callistemon salignus
Melaleuca armillaris	Dodonaea viscosa
Melaleuca nesophila	Eremophila oppositifolia
Melaleuca squarrosa	Eucalyptus caesia
Metrosideros excelsa	Eucalyptus eremophila
	Eucalyptus forrestiana
	Eucalyptus steedmani
	Eucalyptus torquata
	Geijera parviflora
	Leptospermum pubescens
	Prosopis glandulosa
Medium—18 to 25 ft.	
Acmena smithi	Alectryon subcinereus
Agonis flexuosa	Aleurites fordi
Elaeocarpus cyaneus	Cassia brewsteri
Eucalyptus stricklandi	Eucalyptus calycogona
Eugenia paniculata australis	Grevillea striata
Pittosporum phyllyraeoides	Melaleuca pubescens
Prunus lusitanica	Tamarix aphylla
Quercus ilex	
Stenocarpus salignus	
Large—center planting	
Brachychiton discolor	Acacia pendula
Casuarina glauca	Casuarina luehmanni
Eucalyptus gummifera	
Syzygium ventenatti	

Extensive work has been done in Victoria by the Forests Commission to determine the best trees for certain localities, depending on the amount of rainfall. Certain parts of that State get less than 15 inches of rain annually; a surprisingly large number of trees will thrive under such conditions, particularly if some irrigation is available. Other parts of Victoria have rainfall of 20, 25, 40 or even more per annum, and tree planting recommendations for these different areas are worked out in some detail in a booklet[10] issued in 1945 at Melbourne. Content with establishing the relation of rainfall to the various species, the booklet suggests no additional street trees.

The same sort of selective progress has been made all over the tropical world as interest in avenue trees has grown; older selections that were tried and found wanting have been discarded, and new choices of trees have been made. Nowhere is this trend better marked than in a comparison of various lists of avenue trees in H. F. Macmillan's "Tropical Planting and Gardening,"[11] the second edition (1914) representing opinion at that time, and the fourth edition (1935) reflecting changed views. Macmillan's lists were made for Ceylon primarily, but as the trees suggested by him appear also in Indian and Malayan reference books, and in plantings at Singapore, an effort is made here to present a composite opinion for that part of the tropical world. All descriptions are quoted from Macmillan unless otherwise stated.

Macmillan in 1914 made this list of "Shade trees for roadsides. Elevation below 2000 feet. Rainfall 70 inches or more." (Items marked with an asterisk (*) are repeated in Macmillan's 1935 list but the others are omitted.)

Canarium commune. (Combretaceae). JAVA ALMOND. Large Malayan tree. Remarkable buttressed trunks. Much cultivated for ornament and shade in Java. Desirable for planting in avenues. Burkill[12] says: "It can be used as a shade tree and the magnificent avenue in the botanic garden at Buitenzorg, which is now more than 100 years old, is made of it. It grows fairly fast."

***Filicium decipiens** (Sapindaceae). An elegant evergreen tree of 50-70 feet. Fern-like foliage. Rather

slow growth. Native of Ceylon. Burkill says: "A handsome tree which is often cultivated and grows well in the Straits Settlements . . . It flowers only rarely in Singapore." A letter from the botanic garden [13] says this "shapely tree is not much planted at present."

***Lafoensia vandelliana** (Lythraceae). Erect, medium-sized tree with small leaves, native of Brazil.

Myroxylon toluiferum (Papilionaceae). BALSAM OF TOLU. Large, handsome tree 70-100 feet with small pinnate leaves. Native of South America. Thrives in rather dry districts.

Parkia roxburghi (Mimosaceae). Immense tree with fine feathery leaves. Native of Malaya. Remarkably handsome, quick growing. Thrives in moist low country. (Syn. **P. javanica.**) (Under the latter name the tree was introduced into Florida several years ago by the Fairchild Tropical Garden and is occasionally grown.)

***Peltophorum ferrugineum** (Caesalpineae). Handsome foliage and flowering tree with fine feathery leaves. Native Ceylon (Syn. **P. roxburghi, P. pterocarpum** and **P. inerme**). (Under the latter name and often called "yellow poinciana," it has been considerably grown in South Florida for 25 years.) Burkill says: "Being a beautiful tree, it is planted in gardens and sometimes on roadsides. It is wind-firm." Foxworthy [14] says that it is an excellent shade-and street-tree, being clean and ornamental, and sending its roots deep so that it does not disturb pavements. A letter from Singapore [13] says the tree flowers beautifully about twice a year there.

***Pithecellobium saman** (Mimosaceae). RAIN TREE. Very large, quick-growing tree with small pinnate leaves. Excellent for roadsides. Native of South America. Acorrespondent in Singapore [13] says: "On a deep soil grows quickly and makes a lofty and shapely tree, one of the best for shade purposes; carries many epiphytes which (in my opinion) add to its beauty."

Pometia eximia (Sapindaceae). Large handsome tree with large, spreading round head. 80-100 feet. Native of moist low country of Ceylon and Malaya.

Pterocarpus indicus (Papilionaceae). PADOUK. Large handsome tree with fine foliage and drooping branches. A profusion of yellow, sweet-scented flowers. Burkill says: "It makes an excellent roadside tree because, though it loses its leaves in spring, the new foliage is produced at once and gives grateful shade in the hottest weather. It is one of the easiest trees to propagate, as it grows readily from seeds or cuttings, and makes exceedingly rapid growth where conditions suit it. The big trees make beautiful avenues. . . . The spread of the branches of a good Angsana from the trunk, may be as much as 60 feet, i. e., as an avenue the tree will arch over a roadway 120 feet wide. They make little litter and branches seldom break." A letter from Singapore [13] says: "Quick growing and shapely. Flowers beautiful but fleeting." Corner [15] says: "It is best known as a roadside tree, for which purpose it excels in the beauty of its vast shady crown and its fragrant yellow flowers."

Terminalia belerica (Combretaceae). MYROBALAN. Very large handsome tree, with a straight, often buttressed trunk and long, horizontal branches. Native of the moist low country of Ceylon, India and Malaya.

Macmillan's 1914 list continues with "Shade trees for roadsides. For semi-dry regions. (Rainfall 50-70 inches)."

Albizzia lebbek. (Mimosaceae). WOMAN'S TONGUE.

***Azadirachta indica** (Meliaceae). Moderate sized tree with straight trunk and spreading branches. Stands drought well. Much planted in avenues in India.

***Caesalpinia coriaria** (Caesalpineae) DIVI-DIVI. Spreading medium sized tree. Greenish-white, sweet-scented flowers

Diospyros embryopteris (Ebenaceae). Moderate sized evergreen tree with spreading branches. Burkill [12] says that a related tree, **D. discolor** is "a tree common in the Philippine Islands almost throughout, planted on roadsides where it gives excellent shade."

Eucalyptus alba (Myrtaceae) WHITE GUM. Tall slender trees with smooth gray bark.

E. citriodoro. LEMON SCENTED GUM. Handsome slender tree with smooth bark.

Mischodon zeylanicus (Euphorbiaceae). Much branched tree to 30-40 feet, suited to dry regions. Young foliage bright pink. Excellent timber.

Myristica laurifolia (Myristicaceae). WILD NUTMEG. Large tree with wide spreading branches and large leaves. Thrives in dry as well as moist areas.

***Peltophorum ferrugineum.**

***Pithecellobium saman.** Thrives in fairly dry districts if planted in good deep soil.

***Poinciana regia** (Caesalpiniae) ROYAL POINCIANA. Singapore [13] correspondent writes: "Irregular in flowering in our uniform climate but always beautiful."

***Polyalthia longifolia** (Annonaceae). Handsome evergreen tree suitable for avenues and roadsides. Much planted as an avenue tree in northern Ceylon and south India. Under the old name of this tree, **Guatteria longifolia,** Cleghorn [16] says: "A highly ornamental erect tree which should be planted in avenues more than it is at present. Some fine trees may be seen at Triplicane and Pondicherry."

Pterocarpus marsupium (Papilionaceae). Widespreading, handsome tree; fine hard timber.

Swietenia macrophylla. (Meliaceae) HONDURAS MAHOGANY. Large handsome tree, suited to dry districts. Singapore [13] correspondent lists it among best of parkway trees there, with the note: "Quick-growing, shapely, with dark glossy leaves; irregularly deciduous."

***Tamarindus indica** (Caesalpiniae). TAMARIND. Large handsome tree suited to dry as well as moist region.

Thespesia populnea (Malvaceae). "Tulip tree" (sic!) PORTIA TREE. Small, much-branched, spreading tree, indigenous to dry regions of Ceylon near the sea. Often planted as an avenue or shade tree. Cleghorn [16] quotes the superintendent of the Royal Agr-Hort cultural Society's Garden: "This is the principal tree in the Madras avenues, and is valuable for its easy growth. It prefers the sea air and saline soil."

By 1935 Macmillan had eliminated 15 of his selections two decades earlier, but under the heading "Trees for avenues, roadsides, etc. that have qualities to recommend them, depending however on locality," in his 1935 edition repeats 11 previous entrics (those marked with [e]) and adds these additional:

Carallia integerrima (Rhizophoraceae). Small or medium, slow-growing symmetrical tree with spreading head and rather small dark green leaves. Specially suited to the seacoast. Entirely evergreen.

Doona ovalifolia (Dipterocarpaceae). Large handsome tree with semi-drooping branches and small, ovate pointed leaves. Moist low country. Endemic.

Fagraea fragrans (Loganiaceae). Ornamental upright evergreen small-leaved tree of Malaya, often planted for ornament in that country. Though of rather slow growth, this has excellent qualities for an avenue tree, retaining its upright, well-balanced habit. Director of the Gardens at Singapore [13] says: "Medium sized, bushy evergreen, best if allowed to retain its lower branches. Shapely. Heavily scented small flowers very profusely once a year." Burkill says: "A beautiful tree . . . planted for ornament and makes a good avenue tree." (Syn. **F. cochinchinensis.**)

Lagerstroemia flos-regina (Syn. **L. speciosa**). (Lythraceae.) QUEEN'S CRAPEMYRTLE. Medium sized tree with spreading branches. Sheds its leaves for short period in dry season. Singapore [13] director says: "Rather slow, untidy for a time before leaf-fall, but very beautiful when flowering, especially the pink and deep magenta varieties."

Mesua ferrea (Guttiferae). CEYLON IRONWOOD. Medium-sized, slow-growing evergreen tree with small dense foliage. Singapore[13] director says: "Very beautiful in symmetrical form as a young tree, in color of young leaves, and in flowers, but little planted because it is slow."

Pongamia glabra (Papilionaceae). INDIAN BEECH. Handsome tree with glossy pinnate leaves, bearing racemes of creamy-white scented flowers. Esteemed in India as a street tree. Good timber. Foliage relished by cattle in time of drought." (Occasionally planted in South Florida, its heavy leaf-shed is found objectionable.)

Swietenia mahagoni (Meliaceae). WEST INDIAN MAHOGANY. Favorite tree for roadsides in northern Ceylon and parts of India. (Much planted in south Florida.)

Cleghorn[10] supplements these lists with the following:

Casuarina muricata (Casuarineae). This tree forms pretty avenues, especially in narrow roads.

Ficus religiosa

Ficus tsiela. No aerial roots. "Preferable to F. Benjamin and F. Indica.")

Ficus nitida.

Millingtonia hortensis (Bignoniaceae). INDIAN CORK TREE. A good tree for planting in avenues. The flowers are pure white and very fragrant. Brandis[17] says: "Cultivated in avenues and gardens in most parts of India."

Parkia biglandulosa (Mimosaceae). This large and elegant tree—is one of the best trees for avenues, but requires care and regular watering.

Sterculia foetida (Sterculiaceae). This is a large tree, only objectionable from the foetid odor of the flowers and the falling of the leaves.

Cleghorn continues: "Those who have seen the beautiful avenues of *Vateria indica*, and *Artocarpus integrifolia* and *Lagerstroemia flos-regia* in Camara and Malabar; *Shorea robusta* in Gumsur, and those of the Tamarind, Banyan and Mango in Mysore, cannot fail to appreciate their value and importance. *Vateria indica* forms beautiful avenues in Nagar, Malabar and Camara, the foliage is dense and the blossoms very fragrant. It was a favorite tree with the old rajahs and there are magnificent old trees near Bednore."

Singapore and other cities of Malaya are using several trees not found on Indian lists. At Singapore[18] these include:

Cassia multijuga "flowers almost continuously here."

C. spectabilis

Casuarina sumatrana Medium sized trees, slow growing, very shapely.

Eugenia grandis. Rather tall, fairly quick growing, evergreen, flowers 3 times a year. Not especially beautiful, but useful especially near the sea.

Gardenia carinata. Smallish tree, evergreen; good foliage; fine large fragrant flowers once a year and sometimes more frequently.

Michelia alba. Evergreen bushy tree, medium size, bearing heavily scented flowers frequently. Never sets fruit in Singapore.

Parinarium corymbosum: A tall shapely tree, not wide-spreading; slow growing. Evergreen.

Burkill[12] adds the following to the list of avenue trees in the Far East:

Arfeuillea arborescens (Sapindaceae) 45'. It grows well in Singapore and has been recommended for use as a roadside tree.

Calophyllum inophyllum. The tree makes very slow growth. It likes a sandy coast and avenues are made of it in Indo-China near the sea. Wigman suggests it for a roadside shade tree in such places as Java. Ridley said that it is so used in Malaya; that it grows well, being so strong that the winds do not break it, and keeps free from parasites and epiphytes.

Gmelina arborea (Verbenaceae). Tree of moderate size or sometimes large with brilliant orange flowers. It grows fast and is not uncommonly planted in India in gardens and in avenues.

Guazuma ulmifolia (Sterculiaceae). It is used as a roadside shade tree in India and the Dutch Indies.

Hura crepitans. In French Indo-China, on good soil, it made an excellent avenue tree.

In British Guiana[18] the trees found best adapted to street and parkway planting are:

COMBINATION OF SHADE AND FLOWERS
Cassia multijuga
Cassia nodosa
Couroupita guianensis
Delonia regia
Lagerstroemia indica
Lagerstroemia speciosa
Pachira aquatica
Peltophorum inerme
Spathodea campanulata
Sterculia apetala
COMBINATION OF PARTIAL SHADE AND FLOWERS
Jacaranda rhombifolia
Triplaris surinamensis
SHADE WITH WIDE SPREAD
Ficus benghalensis
Ficus religiosa
Hura crepitans
Melaleuca leucadendron
Pithecellobium saman
Platymiscium polystachyum
Swietenia mahagoni
GRACEFUL FOR THEIR GROWTH AND SHOWY SEED
Adenanthera pavonina
Pithecellobium arboreum

In the Panama Canal Zone[19] the trees recommended for street and parkway planting are:

Achras zapota—SAPODILLA
Anacardium excelsum—WILD CASHEW
Bauhinia monandra
Bauhinia variegata
Calophyllum calaba
Cassia fistula
Cassia grandis
Cassia nodosa
Cassia siamea
Casuarina equisetifolia
Eugenia grandis
Eugenia malaccense
Ficus retusa
Ficus waringiana
Lagerstroemia speciosa
Mimusops elengi
Peltophorum inerme
Pithecellobium saman
Posoqueria latifolia
Spathodea campanulata
Swietenia macrophylla
Swietenia mahagoni
Tabebuia guayacan
Tabebuia pentaphylla

Gunther E. Maul, director of the Museu Municipal do Funchal, on the Island of Madeira, writes:

"With regard to parkway and avenue trees, most extensively used here is **Jacaranda mimosifolia.** It grows quickly and does fairly well in streets paved with stones set in mortar. In spring, when they are covered in blue they present a striking show, though, personally ,I always think that they show up much better in parks with higher darker trees as a background, for the blue flowers do not stand out very well against the blue sky.

"Until some years ago we had long stretches of **Ficus indica.** They made a massive stately impression with their thick stems and dense darkgreen shiny foliage. They were all taken down, as some suddenly started crashing down without outwardly the least sign, thus constituting a danger to the public. One person was actually killed. The trees had grown thick roots which had raised the pavement and it was found that the slightest removal of these roots caused the trees to perish.

"Latterly **Tipuana tipu** has been largely grown in avenues. This is a most graceful plant which in spring becomes covered with deep yellow crinkly flowers, and it grows into a sightly tree within a few years. The new delicate leaves come out simultaneously with the flowers. Even after the bloom has fallen they are a most pleasing sight and give a very agreeable half-shade. A slight drawback is that their roots are apt to raise the surrounding pavement. Perhaps planting them rather deep could avert this."

Perhaps the most outstanding effort in any part of the world to select trees suitable for use in parkway planting, has been made in Brazil by F. C. Hoehne, director of the Botanical Institute at Sao Paulo. In a book[39] published (in Portuguese) in 1944 entitled "The City Planting of Trees–the fruits of my observations and experiences over a period of many years," Mr. Hoehne has selected and described upwards of 426 species of native Brazilian trees that are particularly adapted to street work. The wealth of material is overwhelming; only a dozen of the trees mentioned are known in the United States even to specialists. Nevertheless, as several Brazilian trees are being grown successfully in Florida and California, it is to be expected that many more on the Hoehne list will lend themselves to adaptation in this country.

Ignoring 350 of the trees that Hoehne recommends, the following list of 80 trees is selected because in describing them the author has resorted to superlatives–apparently they are the cream of the Brazilian crop. Because most of the genera and species are entirely strange to North American students of trees, the natural orders are given and the author's description quoted briefly:

ANACARDIACEAE
- **Myracrodruon urundeuva**—"very beautiful in form". (weeping)

ANONACEAE
- **Annona salzmanni**—"a very beautiful tree, elegant in form"

APOCYNACEAE
- **Aspidospermum olivaceum**—"a beautiful tree"
- **Tabernaemontana hilariana**—"small tree, copious white flowers"

BIGNONIACEAE
- **Tecoma caraiba**—"a very beautiful tree"
- **Tecoma chrysothricha**—"a very pretty tree"
- **Tecoma lapacho**—"of very beautiful form"
- **Tecoma ochraceae**—"medium size and very elegant"

BORAGINACEAE
- **Cordia trichotoma**—"tree of lovely shape, large white flowers"
- **Patagonula americana**—"pretty tree"

CANELLACEAE
- **Cinnamodendron axillare**—"an elegant little tree"

CAPPARIDACEAE
- **Crataeva tapia**—"pretty tree"

CARYOCARACEAE
- **Caryocar crenatum**—"highly recommended for city planting"

CELASTRACEAE
- **Elaeodendron quadrangulatum**—"beautiful, lustrous foliage"
- **Maytenus alaternoides**—"tree of beautiful aspect"
- **Plenckia populnea**—"beautiful tree"

COMBRETACEAE
- **Terminalia brasiliensis**—"pretty tree"
- **T. tanibouca**—"pretty to look at"

CUNONIACEAE
- **Belangera tomentosa**—"a beautiful, rapid growing tree"

ELAEOCARPACEAE
- **Sloanea Fernando-costae**—"a very beautiful tree" —"many other species of very lovely form are included in this genus"

EUPHORBIACEAE
- **Gonatogyne brasiliensis**—"an extremely pretty tree"

FLACOURTIACEAE
- **Casearia parvifolia**—"an extremely pretty tree"

GUTTIFERAE
- **Tavomita bahiensis**—"ample and very lovely foliage"

ICACINACEAE
- **Villaresia dichotoma**—"a beautiful tree"

LAURACEAE
- **Ocotea pretiosa**—"tree with beautifully formed crown"

LECYTHIDACEAE
- **Cariniana excelsa**—"elegant tree with beautiful foliage"
- **Gustavia augusta**—"exceedingly beautiful large tree . . . pretty flowers"

CAESALPINIACEAE
- **Caesalpinia peltophoroides**—"very pretty tree"
- **Cassia leptophylla**—"pretty tree; flowers very ornamental"
- **Heterostemon mimosoides**—"very lovely appearance"
- **Holocalyx glaziovi**—"extra pretty tree"
- **Luetzelburgia praecox**—"pretty tree, small size"
- **Macrolobium rondonianum**—"good tree; flowers very lovely"
- **Peltogyne confertiflora**—"very good tree"
- **Pterogyne nitens**—"very beautiful tree"
- **Sclerolobium paniculatum**—"very good tree"
- **Swartzia langsdorffi**—"well shaped tree; flowers exceedingly ornamental"
- **Tachygalia multijuga**—"very good tree"

MIMOSACEAE
- **Pithecellobium saman**—"a very beautiful large tree"
- **Prosopis juliflora**—"elegant form and pretty foliage"

PAPILIONACEAE
- **Andira anthelminthica**—"small tree of elegant form"
- **Dalbergia foliosa**—"elegant form, beautiful foliage"

Machaerium foliosum—"elegant form, beautiful foliage"
Machaerium stipitatum—"very good; recommended for fine foliage"
Platycyamus regnelli—"pretty form; exceedingly lovely rose-violet flowers"
Platypodium elegans—"good shape; very beautiful yellow flowers"
Pterocarpus violaceus—"good form and lovely flowers"
Tipuana tipu—"good tree; recommended only for wide parkways"

LYTHRACEAE
Physocalymma scaberrimum—"precocious flowering tree"

MAGNOLIACEAE
Drimys winteri—"good tree with small foliage"

MALPIGHIACEAE
Lophanthera lactescens
Lophanthera pendula—"two exceedingly marvelous trees . . . with long, hanging clusters of flowers of extraordinarily decorative effect."

MELASTOMACEAE
Miconia cabucu—"big tree of fine form"
Mouriria grandiflora—"very beautiful form"

MYRTACEAE
Paivaea langsdorffi—"very beautiful in form; delicious acid fruits"

NYCTAGINACEAE
Torrubia schmidtiana—"exceedingly pretty shape"

OCHNACEAE
Ouratea castaneaefolia—"very pretty foliage"

PHYTOLACCACEAE
Gallesia gorazema—"a beautiful tree"

PODOCARPACEAE
Podocarpus lamberti—"a beautiful tree"

ROSACEAE
Hirtella brachystachya—"tree of fine form"
Mouquilea floribunda—"beautiful crown"

RUBIACEAE
Alseis floribunda—"a very good tree"
Capirona descorticans—"vermilion flowers with scarlet calyx"

RUTACEAE
Balfourodendron riedelianum—"tree of pretty form"
Esenbeckia grandiflora—"tree of very elegant aspect"
Metrodorea nigra—"very good tree; vermilion flowers"
Metrodorea pubescens—"a beautiful tree"

SAPOTACEAE
Ecclinusa ramiflora—"beautiful tree"
Lacuma forta—"very pretty"
Sideroxylon gardnerianum—"exceedingly pretty tree"

STYRACEAE
Pamphilia aurea—"tree of elegant shape"

SYMPLOCOSACEAE
Symplocos glandulosa-marginata—"flowers abundant, ornamental and exceedingly lovely"

THEACEAE
Ternstroemia punctata—"a graceful ornamental tree, with pretty flowers and lovely aspect"

VOCHYSIACEAE—"exceedingly beautiful trees"
Callisthene sp.—"very pretty foliage; the abundant flowers are white, yellow or blue"
Qualea ingens—"especially recommended . . . the rose-purple flowers are large and ornamental"
Vochysia bifalcata—'majestic size and beautiful crown; the abundant yellow flowers are very ornamental"
Vochysia tucanorum—"an exceedingly pretty tree"
Salvertia convalariaeodora—"an exceedingly pretty tree"

IV

Any tabulation of trees for street planting in South Florida suggested here would represent a composite picture of what some municipalities are doing, what some hope to do, and what park superintendents in general might reasonably undertake as the basis of a tree-planting program.

The trees on the following list, which represent the author's opinion and experience, have these major points of merit: (1) they are entirely pest-free and do not require a spray program to maintain; (2) they have all been grown experimentally in South Florida, have stood the tests of storm, neglect and even flood and are more than ordinarily resistant to such destructive elements; (3) propagating material can be readily obtained.

Here is my list of street trees Florida starts with; but rather than rest with these, we need to raise our horizons to encompass many of the other highly desirable trees the rest of the warmer world can offer:

FOR HIGHWAYS NEAR SALT WATER:
Achras zapote SAPODILLA
Ardisia paniculata MARLBERRY
Calophyllum inophyllum KAMANI
Coccolobis laurifolia PIGEON PLUM
Conocarpus erectus BUTTONWOOD
Eugenia hookerianum
Eugenia myrtifolia
Ochrosia elliptica
Paritium clatum BLUE MAHOE

MEDIUM PARKWAYS:
Cedrela toona
Diospyros embryopteris
Harpullia arborea
Koelreuteria formosans GOLDEN RAIN TREE
Lagerstroemia thorelli
Lagerstroemia speciosa QUEEN'S CRAPEMYRTLE
Lagerstroemia turbinata
Putranjiva roxburghi
Terminalia muelleri

FOR NARROW PARKWAYS:
Bucida buceras BLACK OLIVE
Cupania canescens
Callistemon speciosus SHOWY BOTTLEBRUSH (Erroneously distributed in the trade as **Melaleuca genistifolia**)
Swietenia mahagoni WEST INDIES MAHOGANY
Tabebuia pallida (evergreen type)
Thespesia populnea PORTIA TREE (only if grown from seed, not cuttings)

FOR WIDE PARKWAYS:
Aleurites trisperma MU OIL NUT
Eugenia malaccense MALAY APPLE
Lysiloma latisiliqua
Melaleuca leucadendron CAJEPUT (in clusters)
Oxandra lanceolata
Swietenia macrophylla HONDURAS MAHOGANY
Syzygium cumini JAMBOLAN PLUM
Tabebuia argentea SILVER TRUMPET TREE
Triplaris surinamensis
Triplaris cumingiana

FOR PARKWAYS BETWEEN DOUBLE STREETS:
Ficus benjamina WEEPING FIG
Ficus nitida (thrip-proof type)
Peltophorum inerme
Vitex parviflora

FOR PARKWAYS ON HIGH SANDY LAND:
Acacia seyal
Acacia scorpioides GUM ARABIC TREE
Achras zapote SAPODILLA
Coccolobis laurifolia PIGEON PLUM
Eugenia jambos ROSE APPLE
Ilex paraguariensis PARAGUAY TEATREE
Mimusops elengi
Tamarindus indica TAMARIND

V

Certain trees showed exceptional ability in the August 26th, 1949 hurricane at Stuart, Florida, and vicinity, either to drop their leaves in the 162-mile-an-hour wind, and thus offer small resistance, or to bend over before the wind without being torn from the ground. Those trees which showed the least damage from hurricane winds were:

Albizzia coriaria
Albizzia procera
Albizzia stipulata
Bucida buceras
Calliandra haematocephala
Calliandra surinamensis
Callistemon citrinus
Callistemon phoenicius
Callistemon speciosus
Calophyllum antillanum
Calophyllum inophyllum
Delonix regia
Ficus gnapholocarpa
Ficus krischna
Lonchocarpus sericeus
Lonchocarpus violaceus
Ochroma lagopus
Pleiogynium solandri
Plumeria emarginata
Plumeria rubra
Pongamia glabra (Cuba—"the hurricane tree")
Pterocarpus echinatus
Pterocarpus indicus
Sterculea apetala
Tabebuia pallida
Tabebuia pentaphylla
Tabebuia rosea
Tamarindus indica
Vitex parviflora

VI

Certain trees should be avoided in parkway planting because their fruits, their flowers, or their latex are poisonous, or the flowers themselves have an objectionable odor, or the leaves or seeds are nettle-like, or their roots seek the surface and are destructive of sidewalks or sewers. Typical examples can be cited. Among trees which should not be planted along streets, or in parkways, without a full understanding of the difficulties involved are:

Euphorbia sp.—The latex of many species is poisonous, may even cause instant blindness.

Ficus sp.—Many beautiful species, like *F. benjamina* and *F. nitida*, get entirely too big for city streets; the latter frequently in Florida becomes 150 feet across under favorable conditions. *F. bengalhensis* has too many aerial roots and the same applies to some other species sometimes planted for ornament. *F. religioso* becomes too large for any except widest parkways. *F. elastica* has adventitious roots, frequently 3 inches or more in diameter, running on the surface of the ground for 100 feet or more from the tree.

Lagunaria pattersoni, although pretty in the right place, the nettle-like seed pods are highly objectionable features.

Sterculia foetida—The odor of the flowers is very offensive, but does not persist long; it is a beautiful tree if planted away from human habitation.

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PARATHION CONTROLS SOME OF THE INSECT PESTS ON WOODY ORNAMENTALS

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Flower garden troubles are due to many causes such as poor soil, unfavorable weather conditions, plant diseases, attacks by insects and neglect. Although the main purpose of this talk is to discuss some of the insect problems may I interject a few words about neglect. To obtain satisfactory results from the ornamentals one must take care of them. Many of the plant problems which I have observed in the Gainesville area could be directly attributed to the failure of the gardener to take any action whatever. There are so many problems which are inevitable in a year round climate, such as ours, that one must constantly be on the alert! Don't neglect your ornamentals for they are entirely dependent on you. Plants in a healthy vigorous condition are best able to withstand or outgrow light injury by insects. Consequently it is important that the best horticultural practices be followed in regard to planting, watering, fertilizing, and cultivation.

Insects in the garden are not new. They were probably waiting for Adam and Eve in the Garden of Eden and they have been aiding and bedeviling every gardener since that time. When you bewail the fate that seems to have sent "bugs" just to your personal address, rest assured that others are wailing just as loud! Not all the insects encountered in the flower garden are injurious. A number of species help us by destroying injurious pests. A few examples of these are the praying mantis, lady bird beetles, certain ground beetles, assassin bugs and the larvae of syrphid flies. This discussion will cover only information accumulated as a result of experiments made during the past year in the Gainesville area. It is not to be inferred that any of the suggestions involving control are made as permanent recommendations.

INSECT PESTS: Numerous experiments have been performed on several of our favorite woody ornamentals. The ornamentals and the insect pests infesting them against which effective controls have evolved are as follows: Holly: Florida wax scale, Florida red scale, pustule scale, oyster shell scale, tessellated or palm scale, and purple mites; Azaleas: Lacebugs, leaf miner, azalea mealybug, thrips, peony scale, whitefly, and several species of mites; Camellias: Florida red scale, tea scale, camellia scale, aphids, flea beetles, and rust mites; Gardenias: Citrus whitefly, mealybugs, Florida wax scale, and green shield scale; Roses: Thrips, mealy bugs and aphids.

SPRAY APPLICATION PREREQUISITES: Applications of insecticides made by means of a Dobbins quart size hand sprayer gave very poor results. Applications made by means of a Champion three-gallon knapsack sprayer and a Dobbins 25-gallon power sprayer gave excellent results. The best results were obtained using a double nozzle which was tilted upwards about 45 degrees. The extension spray tube should be at least five feet long which will permit thorough coverage of the lower surfaces of the leaves. The insecticide should be thoroughly mixed with the water prior to application. When using wettable powder formulations some means should be provided for agitating the mixture.

EFFECTIVENESS OF PARATHION: Parathion, 15 percent wettable powder, used at the rate of one ounce in six gallons of water has proved very effective in controlling soft-bodied insects such as citrus whitefly, mealybugs, flower thrips, and aphids. Parathion, 15 percent wettable powder, used at the rate of one ounce in three gallons of water, has proved effective in controlling many of the armored scales. The armored scales secrete a chitinous covering over the body which gives considerable protection to the insect and its eggs, thus making control much more difficult. Usually if the insect has been killed the eggs

are also destroyed except in the case of the pustule scale. A second application of spray within two to four weeks is necessary for effective control of pustule scale.

Red spider, purple mites, and rust mites are also effectively controlled with parathion, 15 percent wettable powder, used at the rate of one ounce in six gallons of water. Parathion is not effective in destroying mite eggs and does not have sufficient residual to kill newly hatched mites two to three days after application. A second spray application should be made in two weeks to permit time for all of the eggs to hatch and to eliminate adult mites before they can lay eggs.

COMPATIBILITY: Parathion was used with "Flordo" and C-O-C-S fungicides in treating large blocks of camellias. Parathion appeared to be compatible with these fungicides in every respect.

INSECTICIDE PHYTOTOXICITY: To date, the papaya is the only plant which has shown a definite phytotoxic reaction to the application of parathion sprays. *Podocarpus nigi* also has shown apparent injury. Ardizia and Elaeagnus have also been reported as showing a phytotoxic reaction but tests in the Gainesville area have not indicated any plant injury.

DISCUSSION: While, in general, the results have been very promising, it has been difficult to make a precise evaluation of them. For instance, parathion was very effective in killing crawlers, males and immature female Florida red scales. This was the case with many of the dosages tested while the same dosages often failed to kill the adult female Florida red scale. In this latter instance the action of parathion was very slow—especially in cool weather. Also, though it may not kill in every instance, parathion appears to be of value because it probably reduces the number of eggs laid. Thus a determination of the mortality of adult female scales, which is often used as a test of insecticide efficiency, failed to give a true picture of the effectiveness of parathion. The use of parathion at certain times probably resulted in partial control by still another method. This method was to render females sterile by killing a large proportion of male scales. Thus those females which were not fertilized did not lay eggs and it is suspected that they were more susceptible to attacks by entomophagus fungi.

Several precautions are to be observed when using parathion. Be certain to keep the material labeled at all times. When using this insecticide avoid getting it on the skin and should some get on the skin, wash it off immediately. Stay out of enclosed spaces such as greenhouses, tree canopies, or other similar places where parathion is being dispersed or has been used recently. Stand to the windward side when making applications of this insecticide to avoid drifting spray or dust particles. If these precautions are followed it is felt that there is but little danger involved, especially if the exposure time is short.

GLADIOLUS IN THE FLORIDA GARDEN

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Numerous requests for information on the culture of gladiolus in Florida gardens indicate that increasing numbers of home-owners are growing glads as a hobby. The growth in popularity of this flower over the country has paralleled the rapid growth of the gladiolus flower and bulb industry. Gladiolus is now grown more extensively than any other cut flower plant.

It has been said that gladiolus is a man's flower. Men of various professions and businesses have found the study and growing of this plant so absorbing that their sole livelihood is now the growing of new gladiolus varieties for sale. The growing of glads is enjoyed by tens of thousands of home-owners because (1) gladiolus are easy to grow, (2) they will grow in any garden soil, (3) they are large and

showy flowers with a greater range of color and hues than any other cut flower, (4) they are very suitable as cut flowers for arrangements and corsages, and (5) gladiolus are easily cross-pollenated to form new varieties which differ from one another in many ways including size, shape, color, and disease resistance. Fragrance has been bred into a few of the new ones. Probably no other ornamental plant receives as much attention from plant breeders, including amateurs.

Of the many hundreds of varieties available, the choice for the garden narrows down to those varieties which do not need to be sprayed to control diseases. The gardener should not try to grow some of the varieties commonly found on the cut-flower farms of Florida. Such varieties as Picardy, Wanda, Corona, Leading Lady, Silver Wings, Bingo, New Europe, Ethel Cave-Cole, Algonquin, Badger Beauty, Pink Radiance, Stoplight (red), Surfside and Vredenburg are very susceptible to certain diseases and are therefore not suitable for the home garden.

Some varieties found to be fairly resistant to gladiolus diseases prevalent in Florida are:

White: Annamae, Heavenly White, June Bells, Maid of Orleans, Parma, Snow Princess, Wax Model.

Cream: Agatha, Canopus, Pacifica, White Gold, Winston.

Yellow: Elizabeth Maier, Gate of Heaven, Nugget, Spotlight.

Buff: Apricot Glow, Color Marvel, Paradise, Patrol.

Orange: Abnaki, Daphne, Marqueeta, Trocadero.

Salmon: Dauntless, Dieppe, Margaret Fulton, Ogarita.

Scarlet: J. V. Konynenburg, Seminole, Valeria.

Pink: Big Top, Blessed Damosel, Bridesmaid, Hearts' Desire, Ivy Robertson, Jeanie, Lady Boo, Phantom Beauty, Spic & Span.

Red: Birch Red, Black Panther, Firebrand, Rocket.

Rose: Chamouny, Rosa van Lima, Rose O'Day.

Lavender: Elizabeth the Queen, Lavender and Gold, Lavender Prince.

Purple: Convoy, Purple Supreme, Vulcan.

Violet: Blue Beauty.

Smoky shades: Bolero, Dusty Miller.

These varieties are sold by some of the many bulb growers located in various parts of the country. The names of these growers may be obtained from commercial growers of cut flowers and from publications of the North American Gladiolus Council and of the New England Gladiolus Society.

Some of these varieties are obtainable only from northern or western bulb growers who harvest bulbs in the fall. Their bulbs can be mailed to Florida by December or January at which time they may be planted. Upon receipt, the package of bulbs should be opened and the bulbs kept in an airy, dry place. If it is desired to hold the bulbs for a month or more before planting, they should be placed in a refrigerator or in a cool place where there is no danger of freezing. The bulbs should be planted before the roots or shoots grow out.

Gladiolus can be planted at any time of the year in south Florida providing the bulbs are held in cold storage. There are no particular soil requirements, any garden soil being suitable if there is good drainage. The bulbs are planted in a shallow furrow and covered about five inches deep. Fertilizer is applied a few days before planting by mixing it to a depth of six inches in the furrow, or the fertilizer may be banded four inches away from either side of the bulbs and about four inches deep at the time of planting. Use any balanced fertilizer containing the minor elements magnesium, manganese, zinc, copper, and boron. Use one pound to 15 feet of row. During the rainy season, it would be best to use a fertilizer with half of the nitrogen derived from insoluble organic materials. Do not use a fertilizer containing calcium cyanamid. Two or three side-dressings of a vegetable fertilizer should be applied in furrows either side of the row as the crop grows. An inexpensive fertilizer without minor elements and without organic nitrogen may be used for side-dressing. Use two pounds per 100 feet of row for each

side-dressing. These applications may be made at two-week intervals until the fourth leaf appears, after which no fertilizer is ordinarily used. The fertilizer bands should be placed just beyond the extent of root growth without breaking the roots. Always apply fertilizer when the soil is moist, or, if the soil is not moist, irrigate immediately after fertilizing. Apply an inch of water by sprinkling.

Gladiolus should be irrigated moderately. The soil should not be allowed to become saturated with water, nor should it be allowed to dry out, although a dry surface mulch is desirable. In most soils gladiolus do best with an inch of rainfall every week in hot weather and when the plants are in spike, or an inch every two weeks in cool weather. Heavy soils and poorly drained soils require less frequent irrigations.

Shallow cultivations should be made when necessary to control weeds. Beginning as soon as the shoots emerge, dust the plants every week with five percent DDT dust to control worms and thrips. If DDT dust fails to control the insects, or if red spider mites attack the leaves, dust with one percent Parathion. Do not breathe the dust and wash it off hands before smoking or eating. Keep Parathion away from food and children and do not dust vegetables with it just before they are to be consumed.

Most of the recommended varieties are resistant to the Curvularia and Stemphylium leaf spot diseases. These varieties may be attacked during cold weather by Botrytis disease. If it is desired to protect the plants from disease, this may be accomplished by spraying or dusting with Dithane or Parzate.

About five weeks after the flower spike blooms, the bulbs are ready to dig. The bulb is loosened with a shovel or fork and pulled up by the top. The top is clipped off close to the bulb. Dust the bulbs with DDT and keep them in a well ventilated, warm place until the old bulb can be broken off easily. Bulbs are usually "cleaned" two weeks after digging. As soon as the old bulb and roots are cleaned off, press the base of the new bulb in Spergon or in Arasan dust. Use either the wettable or the seed-treating formulation of Spergon. Sprinkle three or five percent DDT dust over the bulbs to control thrips. Keep the bulbs in a dry, cool place. They are ready to plant when root buds appear around the core at the base of the bulb. If bulbs are to be held for staggered plantings over a period of months, they should be kept in a refrigerator. The best temperature is 36° to 42°F. if the bulbs are to be held for several months. Bulbs dug in late spring should be held in cold storage for two months or more if they are to be planted in the fall.

Most garden soils become heavily infested with nematodes. There are three fumigants which may be used in the home garden to control nematodes and certain soil insects: DD, EDB (ethylene dibromide), and MC-2 (methyl bromide). In addition, MC-2 controls weeds and some fungi causing plant disease. DD and EDB are applied as liquids or in capsules. EDB is less toxic to the operator and pleasanter to use than DD. In using these materials, follow the manufacturers' directions carefully.

MC-2 treatment is particularly adapted to the home garden because it is a convenient and a practically fool-proof method of controlling weeds, soil insects, and nematodes. MC-2 is methyl bromide plus two percent of the "warning" gas, chloropicrin, held under pressure in one-pound cans. The soil should be well prepared and moistened as previously described. It is covered with gas-proof paper or treated tarpaulin. The central area of the cover is supported a few inches off the soil and the edges of the cover are buried with some soil. Release of the gas under the cover is accomplished with the aid of a "Jiffy applicator." Merchants who sell MC-2 should be consulted regarding type of cover to use and method of treating the soil. Leave the cover on two or three days. After the cover has been removed an hour or two the soil may be planted. Do not contaminate the area with untreated soil.

Tests indicate that gladiolus bulbs and bulblets grow much better when mulched with aluminum foil. This mulch will keep down

weeds, hold moisture, and sometimes save fertilizer. The fertilizer is applied as the bulbs are planted, placing the fertilizer about six inches deep and four to six inches either side of the bulbs. A 12 to 18 inch strip of foil is placed on the soil either side of the row so that an uncovered area two or three inches wide is left directly over the planted bulbs. The edges of the foil must be weighted down to prevent tearing by the wind. The foil is left in place until the bulbs are dug. Water can be run down the row for irrigation if necessary. Fertilizer should be kept away from the foil because some fertilizer salts can destroy the metal. Mulching with other materials also would presumably be helpful in growing gladiolus.

THE GENUS JASMINUM IN FLORIDA

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Species of the genus *Jasminum* have been grown as ornamental plants, mostly in the tropical and sub-tropical areas around the world, for many hundreds of years. The genus name *Jasminum* is also used as a common name for members of this genus and they are also called jasmine and jessamine, all of which are accepted common names. In fact, certain sweet scented species of *Jasminum* are so well known that several other plants which do not belong to the genus *Jasminum* but which have sweet scented flowers are also called jasmine or jessamine. The so-called Spanish or Catalonia jasmine is used in the manufacture of perfume in Europe.

Several species have been brought into Florida and a number of these are now used to a considerable extent in landscaping. The nomenclature of the *Jasminum* is badly confused so that the correct name is not always applied to a species. Because of this there are several species that are now being distributed under the incorrect name in Florida.

A simple way to separate the species growing in Florida would be to group them first on the basis of flower color into those having white flowers and those with yellow flowers. Each of the flower color groups can, in turn, be divided into those with simple leaves and those with compound leaves.

White Flowers

SIMPLE LEAVES. The furry or downy jasmine, *Jasminum multiflorum* Andr. (*J. pubescens* Wild.), a native of India, is probably the one most planted in Florida. The pure white star-shaped flowers, about an inch across, are borne in few to many flowered clusters. The calyx teeth are about ⅛ inch long and covered with spreading yellow hairs. Though flowers are in evidence throughout most of the year, they are produced in greatest abundance during the summer and fall months. The flowers are not fragrant. It is a strong woody vine which will climb to a height of 20 or more feet by scrambling over its support. This plant is more commonly grown as a shrub than as a vine. Its deep green foliage is dense and the young leaves and stems are quite hairy or pubescent. The leaves are simple, opposite, acute, rounded or slightly heart-shaped at base and 1 to 3 inches long. This plant is usually severely injured by temperatures of 25°F. or lower but it comes back quickly from the roots and will bloom again in the fall.

The pinwheel or star jasmine, *Jasminum gracillimum* Hook., from North Borneo, is very similar in general appearance to the furry jasmine so that there is little choice or distinction made between them for ornamental plantings. It has a more graceful flowering habit, the branches are less pubescent and the somewhat larger flowers are fragrant and are borne in dense hanging heads. The calyx is sparsely covered with close not spreading pubescence (Fig. 1-E).

Jasminum sambac Ait., the Arabian jasmine, came to us from India where it is native. It is an old favorite which may be grown as a low climbing vine or trained as a shrub. The very

fragrant, pure white flowers, from 1½ to 2 inches across, are produced during the summer and fall months in few to many-flowered clusters. There are two varieties of this species, Grand Duke, which is double flowered, and Maid of Orleans, which has single or occasionally double flowers. The simple leaves, borne opposite or in threes, are elliptic or broad-ovate in shape, dark green, from 1½ to 3 inches long and prominently veined (Fig. 1-B). This plant is slightly hardier than the furry jasmine.

Jasminum amplexicaule Don. (*J. undulatum* Ker.), a native of India, has become increasingly popular since its introduction and probably is in greater demand today than any other jasmine planted in Florida. Unfortunately, this plant is now widely known and distributed under the erroneous botanical name of *Jasminum ilicifolium*. It is a strong growing woody vine which climbs by scrambling over its support. The flowers, in evidence during most of the year, are produced in few to many flowered clusters at the tips of side branches that develop from the leaf axils along the old stem. The bud is tinted pink on the outside but the flowers are white when open and are about 1¼ inches across. The calyx teeth are prominent, sharp-pointed and stand at right angles to the tube as the flowers mature. The simple leaves are opposite, glossy dark green, ovate-lanceolate in shape and from 2 to 4 inches in length (Fig. 1-A). This plant is climatically adapted to the southern half of the peninsula.

Jasminum gracile Andr., the Australian jasmine, is similar in growth habit and general appearance of the foliage to *J. amplexicaule;* however, the dark green leaves are not as long and are wider in comparison with their length. This plant is commonly distributed under the erroneous botanical name of *jasminum simplicifolium* in Florida. The pure white flowers, from ¾ to 1 inch across, are borne in clusters in the spring and at irregular intervals during the rest of the year (Fig. 1-C). It is adapted climatically to the southern half of the peninsula.

The goldcoast jasmine, *Jasminum dichotomum* Vahl. (F. P. I. No. 73067), from West Africa, has been introduced into Florida in recent years. It is a vigorous growing, climbing woody vine with large, dark green leaves. The small, slightly fragrant, flowers are borne in much branched terminal clusters at intervals throughout the year (Fig. 1-D). Unopened flower buds are tinged dark red on the outside but open flowers are pure white on the inside of the petals. This species fruits freely in southern Florida and, under some conditions, may become a weed plant as a result of birds spreading the seeds. The plant is semi-hardy and should be planted only in the southern half of the peninsula.

COMPOUND LEAVES. The common jasmine or poets jasmine, *Jasminum officinale grandiflorium* (L.) Bailey, is native of an area extending from Iran to China. It is one of the best known species and is used in the manufacture of perfume. This plant is a scrambling low climbing vine that can easily be trained as a shrub. It has become naturalized in southern Florida and in this area blooms the year around. The pure white, strongly fragrant flowers, about 1½ inches across, are produced in loose clusters. The calyx teeth are linear, prominent and from ¼ to ½ inch long. The compound leaves are opposite and have from 5 to 9 elliptic or ovate acute leaflets ½ to 2½ inches long. This species is hardy throughout the state.

Jasminum azoricum L., the Azores jasmine, from the Canary Islands, is well adapted to southern Florida. It is a strong growing woody vine which will climb to 20 or more feet in height and produce a dense cover. The small, fragrant, white flowers, about an inch across, are borne in many-flowered cymes and are produced at intervals throughout the year. The opposite leaves are compound and consist of 3 dark green leaflets. The center leaflet is slightly larger and has a longer leaf stalk. The stems and leaf petioles are strongly pubescent. This plant fruits freely in southern Florida and on the Keys and, as a result, may become a weed plant.

Jasminum bahiense DC., the Bahia jasmine from Brazil, is very similar in appearance to *Jasminum azoricum* and by some is thought to be a variety of it, but the stems are almost

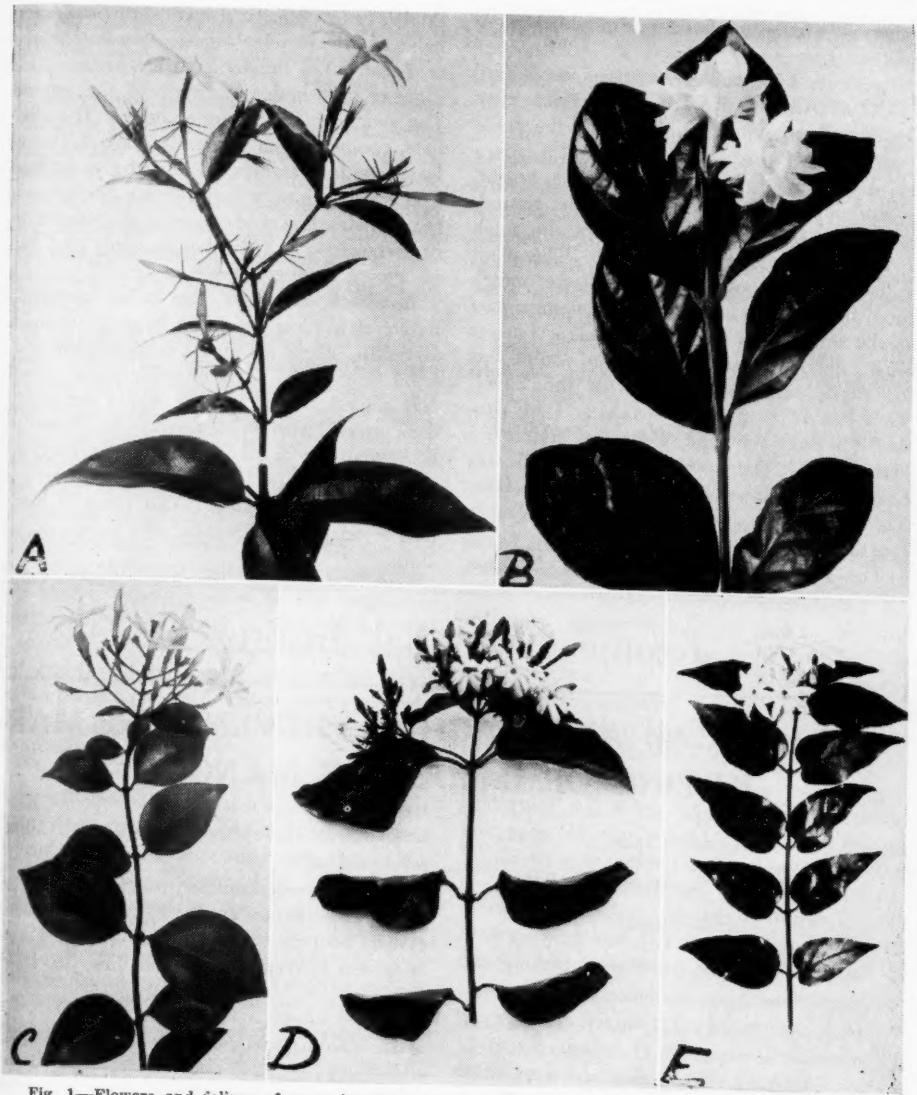

Fig. 1—Flowers and foliage of some jasmines grown in Florida. (A) **Jasminum amplexicaule.** (B) The variety Grand Duke of **J. sambac.** (C) The Australia jasmine, **J. gracile.** (D) **J. dichotomum** from West Africa. (E) The pinwheel jasmine, **J. gracillimum.**

completely glabrous and the leaflets are not much more than half as long but the petioles are twice as long as those of the Azores jasmine. The tubes of the flowers are barely ½ inch long and the flowers are barely ½ inch wide, while the Azores jasmine has flowers that are at least ½ inch wide and many are about an inch across. It is not known whether the Bahia jasmine is in cultivation in Florida but it has become naturalized on the island of Key West,

where it is found in abundance in low swampy places.

YELLOW FLOWERS

COMPOUND LEAVES. *Jasminum mesnyi* Hance (*J. primulinum* Hemsl.), the primrose jasmine, a native of western China, is a shrub that grows up to about 10 feet in height, with drooping branches that reach the ground. The older branches are round but the small branchlets are definitely 4-angled. This plant is hardy throughout the state but flowers much more freely in the north and northwestern part of the state. The large bright yellow flowers with a darker eye are single to semi-double and are borne singly in the axils of the leaves. They are 1½ to 2 inches across and are produced in profusion in late February, March and early April. The opposite compound leaves have 3 oblong-lanceolate almost sessile leaflets. The leaflets may range from 1 to 3 inches in length.

The showy jasmine, *Jasminum floridum* Bunge, from China, is a small shrub with open habit of growth which grows to a height of 3 or 4 feet. The slender branches are erect but some recurve and may droop to the ground. The young branchlets are angular. The alternate, compound leaves usually have 3, though leaves with 5 leaflets are sometimes present. The small, golden yellow flowers are borne in few to many flowered cymes in the late winter or early spring. This plant is hardy and may be grown throughout the state.

Jasminum humile L., the Italian jasmine, a native of tropical Asia, is a large shrub up to 20 feet in height with weak branches and open habit of growth. The branchlets are smooth and angled. The alternate leaves are glossy, dark green, with 3 to 7 ovate to lanceolate leaflets up to 2 inches long. The fragrant, yellow flowers, to 1 inch across, are borne in clusters in early spring. This plant is hardy and is adapted throughout the range of the state.

Krome Memorial Institute

A PRACTICAL APPROACH TO PREVENT THE MARKETING OF IMMATURE MANGOS

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For some time the practice of picking and marketing immature undeveloped mango fruits for fresh fruit consumption has been practiced by a number of growers and shipping establishments. To cite an example or two, it might be mentioned that during the 1948 season it was observed near Homestead that Haden mango trees were stripped of their fruit approximately five weeks before any fruits showed signs of ripening on the trees in this area. During 1949 bushels of Brookslate mangos were offered for sale in the Miami market during the month of June, while tree ripened fruits of this variety were not observed in Dade County prior to August.

The following resolution relative to the marketing of immature Haden mangos was unanimously adopted by the Florida Mango Forum in session at West Palm Beach, June 30, 1948:

WHEREAS the growing of Haden mangos is a commercial pursuit in Florida, and

WHEREAS the Haden mango when mature is one of our most delicious fruits, but when picked before maturity is not fit to eat,

WHEREAS the sale of Haden mangos so picked constitutes a fraud perpetrated by the seller upon the consumer and destroys the market, now existing and potential, for mature Haden mangos, and

WHEREAS the practice of selling immature Haden mangos, both by owners and by thieves, is so prevalent as to create a chaotic condition in mango markets every season,

BE IT THEREFORE RESOLVED, that the Florida Mango Forum, in session June 30, 1948, urges the desirability of legislation to stop the selling of immature Haden mangos, and to that end it requests the State Experiment Stations to make the investigations to obtain the facts necessary to formulate a Haden Mango Maturity Law, and

BE IT FURTHER RESOLVED, that when sufficient knowledge has been obtained upon which to base a fair and reasonable maturity law, we urgently request our representatives in the State Legislature to work for the passage of such an Act.

The common practice among conscientious growers in Florida has been to harvest Haden mangos after they have partially ripened on the tree; i. e., to only harvest fruits that show a distinct yellow color break in the ground color of the fruit. Whether this color break is an adequate indication by itself of the stage of ripening of Haden mangos is worthy of investigation.

If only fruit possessing color break is harvested, it would require a dozen to 18 or more pickings per tree in a crop year where one general bloom is experienced. This is an extremely laborious and costly operation. If the number of pickings can be reduced and quality fruit reach the market operational costs would be reduced accordingly.

We have long been familiar with the fact that different mango varieties having their general bloom occurring more or less simultaneously mature their fruits at different seasons. It is this time factor that is worthy of discussion and further analysis to see whether it can be used to advantage in promulgating a workable basis for marketing a high percentage of mature Haden mangos.

A bloom occurring on a Haden tree in February will normally produce tree ripened fruit during June-July. The Cambodiana will ripen its fruit almost simultaneously with that of the Haden if their blooms occur concurrently. Paheri fruit normally ripens several weeks later than the Haden, while the Brookslate will ripen between two to three months later than the Haden where their flowering time is uniform.

Mango bloom does not occur at the same period each year and correspondingly the fruit crop matures either early, normal or late. On occasion, more than one bloom is experienced where fruit set and mature fruits are had from both blooms. The maturity of the fruits from these respective blooms will show approximately the same time interval as between these blooms.

In India, where some research studies have been made on the growth and ripening of several varieties of mangos, the time factor of fruit development, maturity, and ripening is recognized.

Leley et al[1] states that "the life of the Alphonse mango is about 105 days. It requires 90 days to mature on the plant. Then it is put in a grass bed to ripen. This takes another eight or ten days. In the ripe condition the fruit can be preserved for about a week more after which there is functional breakdown of the fruit."

Leley further states " . . . the life of the Alphonse mango may be broadly divided into three phases:

1. Period of adolescence (first 60 days)
2. Period of maturation (next 30 days)
3. Period of senescence (last 15 days).'

It is not proposed in this paper to discuss in detail the findings reported on the chemical and physiological changes that are reported to occur during these three periods. It will be sufficient for now to point out that correlations were found to exist during the different stages of development and ripening including an increase in the amount of total sugars, an increase followed by loss of acidity, a decline in the rate of respiration, starch accumulation, and rate of fruit growth.

With regard to the Alphonse, Leley further reports in "fruits of 60, 75 and 90 days maturity (at time of picking and subject to varying days of storage) there are clear outward indications of ripening. A golden yellow colour is developed and the fruits possess a sweet flavour and taste."

Apparently the Alphonse under Indian conditions is an earlier maturing mango than the Haden is under Florida conditions. Haden fruits under Florida conditions picked under 90 days from fruit set would not ripen off adequately to produce good marketable fruit. Its period of adolescence and maturation is, therefore, somewhat longer.

It has been pointed out earlier that the common procedure in Florida with regard to harvesting Haden mangos has been to harvest only those fruits that have shown a definite

yellow colour break in the ground color of the skin.

In the light of some preliminary observations made during part of the 1949 Haden season some modification of this time of harvest of Haden mangos may be in order. It will require further observations and more detailed studies over several seasons in order to corroborate these findings before one can recommend their translation into proposed regulatory measures.

The first Haden bloom occurring in 1949 in Dade County and to a lesser extent in Palm Beach County was initiated during the first week in February and the peak of panicle bloom was noted during the third week in that month. The first Haden fruits to show yellow color break on the Sub-Tropical Experiment Station trees occurred about the middle of June, or approximately 115 days from peak of bloom.

A lug of Haden mangos was picked from trees growing in Boynton Beach at this time that had no indication of yellow color break in their skin color. These fruits were held at room temperature and within a week the fruits ripened. The flavor and color were good. This was repeated a week later and the same results were obtained.

On Monday, June 27, or approximately 130-135 days from fruit set, two dozen Haden fruits having a green colored skin with no indication of yellow color break were harvested from a tree on the Experiment Station planting and kept on a laboratory table at room temperature. Within three to four days all of these fruits had an advanced yellow color break condition. Eight days after harvesting all of these fruits were apparently devoid of chlorophyll in their skin color.

A taste test was conducted among ten Station employees comparing these fruits with tree ripened Haden mangos harvested two days prior to the test. Four stated a preference for the fruits that were harvested green and stored for eight days while two stated a preference for the tree ripened fruit while the other four individuals said they could not notice any difference in the quality of the fruits sampled.

Apparently under conditions prevailing on the lower East Coast of Florida during February to June 1949, Haden mangos required approximately 115 days to reach a mature condition. Green fruits harvested after this time period ripened into good quality fruits.

Observations of the second bloom which occurred on the lower East Coast were the following: Panicle initiation was observed March 31-April 1 with the peak of panicle bloom occurring during the week of April 10, with first normally developed tree ripened fruit observed by July 20 or approximately 100-105 days from estimated fruit set, or ten to fifteen days earlier than was observed for the first or February bloom.

This difference in time of ripening may be attributable to the better growing conditions experienced between April to July than obtained during February to June.

Fruits showing no color break were harvested 115 days after peak of the second bloom. As in the fruits harvested from the February bloom these ripened within eight days after picking and were all of good quality when subjected to a taste test.

It will be premature at this time to make specific recommendations for use of the time factor for the harvesting of mature green Haden mangos in Florida.

Efforts will be made to study the blossom behavior, including the periodic length of production of fertile blooms; the fruit development and maturity during the ensuing several crop years.

If the findings are consistent with the observations made during 1949, the use of the time factor should be considered as a simple means of preventing the marketing of immature mangos.

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MANGO BUDDING

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Coral Gables

Nursery propagation of mangos at the present time is a varied procedure and employs many different techniques such as eye budding, side veneer grafting and inarching. The degree of success with any one method has been directly dependent on the one doing the work as much as with the method. With the appearance of new varieties of mangos, the scarcity of graftwood has been the limiting factor for growing quickly any large quantity of trees of a new variety. The general method used is the side veneer graft on one year old stock, utilizing a terminal cion for each tree. Consequently tree costs have been kept high and this in many instances has been a controlling factor in setting out increased acreage of budded mangos. In the last few years, some trees of good quality have been coming on the market selling for about half the cost of conventionally grown trees. These have been propagated by eye or chip budding and were grown in one year from seed instead of the two to three years required by most nursery methods.

Popenoe [*] states that shield budding is the method employed by nurserymen in Florida for growing mangos. This is on stock roughly a year old. However, he discusses the low percentage of take and concludes the paragraph with the statement that "at present (1919) there are only a few propagators in the United States who can produce budded mango trees economically and in quantity." So the eye budding of mangos is not new. But, although it was recommended some 30 years ago, the growers realized that much work was needed to make eye budding a general method of mango propagation for the so-called "common-man."

[*] Popence, Wilson, Manual of tropical and subtropical fruits. Macmillan Company, New York 1924.

Fig. 1. Mango rootstocks—2 weeks old on right, 5 weeks old on left.

Fig. 2. Modified chip bud ready for insertion into prepared 2 weeks old stock.

Several individual problems present themselves in making the eye budding of mangos successful. They can be listed briefly as follows: Selection and preparation of budwood, age and condition of stock and season of the year.

With preliminary work on about 1500 stocks at the University of Miami Experimental Farm during this summer, a few of these problems have been partially answered.

It was found necessary to either prepare the budwood or else by chance to find a few sticks with swelling buds. The budwood is prepared by choosing terminals that have hardened or are in the last stages of pink stem, from ¼ to ⅜ inch in diameter (larger wood gives too large a shield). Cut off the leaf petioles to about ¼ inch, leaving only 2 or 3 leaves at the terminal. If the tree is in good growing condition, the bud eyes will be swelled, ready for use in 2 to 3 weeks. If the trees are hard, an application of a high nitrogen fertilizer is advisable. Each terminal will give 5 to 8 buds and a tip which can be sidegrafted.

The preparation of mango seeds for stock plants is important. The husk is removed by cutting along one suture, being careful not to injure the seed. The hulled seed is placed in a sprouting media such as peat, sawdust or other friable material, with the convex edge upward and about one-half inch below the surface. The seeds should be replanted in pots, tubes, or in the nursery row, as soon as they show viability by putting out a short (one inch or less) root or plumule growth. This immediate replanting assures the establishment of the plant for the early budding procedure.

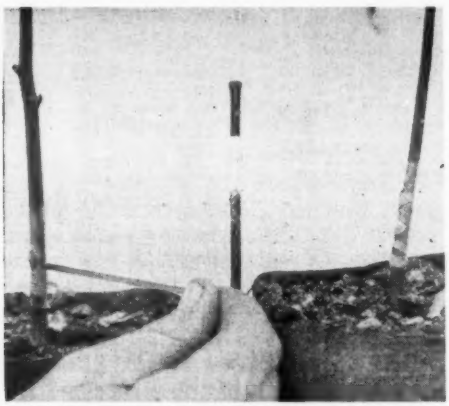

Fig. 3. Wrapping mango buds—2 week old stock, right; 5 week old stock, left. Vinylite rolled on metal rod in center.

Fig. 4. Chip bud, bud-stick and 5 week old stock of mango ready for bud insertion.

The age of the stock is very important on two counts. First, if it is used in the succulent red stage (Fig. 1), which is 2 or 3 weeks old, the bud mortality rate is very low. Second, within four (4) to six (6) weeks from budding the eyes will spring. The high percentage of union is no doubt due to the stock tissue being partially undifferentiated and there is a broader cambial or growing area. The springing of the eyes may be due in part to the heavy and steady supply of food from the cotyledons. The type of bud used on this age stock is a chip bud with a long (1½ to 2") shield (Fig 2). The front of the shield below the eye is cut off through the bark, leaving exposed the cambial area. The cion is in-

serted like a side graft into a deep slanting cut into the stock extending horizontally about one-third through the stem and about 2 in. deep. A small piece of 20 guage vinylite 2 inches wide and long enough to wrap around the stem 1½ times is wrapped to hold the bud and the vinylite snuggly in place (Fig. 3). The film allows the carbon dioxide to diffuse out but retains the moisture next the bud, thus facilitating union of the tissues. Regular watering and an application of starter solution or an application of a mild fertilizer to the plant at this time is a good practice. In two weeks the rubber band and vinylite may be removed and it can be determined if a union has been made. After another week the stock can be cut back to two or three leaves and a final pruning-back of the stock to the upper edge of the bud may be made when the bud sprout is 3 to 4 inches long (Fig. 5). It may be added, that the cion tips from each bud stick mentioned above can be side grafted into these succulent stocks with the same success as the bud eyes. In most cases these tips will spring with more vigor than the bud eyes.

Mango stocks over 4 weeks old have stems on which the bark is green with a well defined cambium and a cortical region showing signs of woodiness. The first flush of leaves have lost their reddish color and are maturing (Fig. 1). At this stage, a slightly different type of bud is used from the foregoing and the stock preparation does not have as deep an incision (Fig. 4). Also, the chip of the bark and wood is removed from the stock by a downward 45 degree cut at the joint which will be the bottom of the exposed cambial area. A typical chip bud is cut of a size and shape to fit the prepared stock. The bottom edge of the shield is cut with a 45° slant to match that on the stock. The bud is placed in position, covered with vinylite and wrapped with a rubber band as in (Fig. 3).

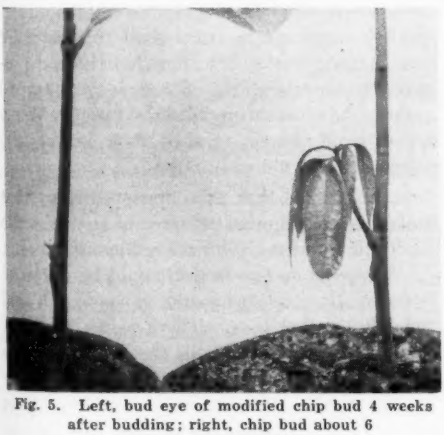

Fig. 5. Left, bud eye of modified chip bud 4 weeks after budding; right, chip bud about 6 weeks after budding.

In three weeks time, the rubber band and vinylite is removed to show whether the bud union has formed. Procedure for a rapid springing of the buds on this older stock has given erratic results. Very likely these buds will all sprout within a few months but this defeats the purpose of growing a tree ready for field planting within a year from seed. No definite recommendations are available at this writing. Further work is in progress at the University of Miami both in nursery practice and anatomical studies on this phase of the problem.

The season for budding is directly correlated with the availability of seed. If the crop is early, budding may be started correspondingly early and continue through the summer as long as the seeds are available. This means an average season of about three months for propagation by the above discussed methods.

Summary

Budding of mangos has been shown to be quite feasible if the stocks are used in the red succulent stage (one to three weeks from sprouting).

A modified chip bud has proven successful on the young stock.

The preparation of budwood is apparently essential and the use of gas-permeable film is advisable.

Budding stocks after the red color has disappeared from the stem has proven successful as to making bud unions. There is as yet no definite method for forcing a rapid sprouting of the bud-eye on this older stock.

The season for budding is dependent on the availability of seed.

PRELIMINARY REPORT ON A CUTTING EXPERIMENT WITH AVOCADO AND MANGO

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Pyke[1] published in the second Annual report on Cacao research in 1932 the results of the vegetative propagation of cacao from soft-wood cuttings. These results were followed by the work of Bobilioff (2) in 1934 on Hevea, when the cuttings were taken from very young nursery plants or from the lower part of the stem of older seedlings.

Nursery plants showing only their first two leaves were ringed with fine wire, and after three weeks the stem above the wire was swollen. Cut at the rings and planted in a moist shady place the cuttings formed roots in another three weeks. No growth substances were used in this experiment. Baptist[3] used strong Hevea seedlings about two years old and cut the stem into pieces 15 inches long. The lower sections rooted to some extent (the lowest 19%, next 3%, third from base 3% and when growth substance was used the percentages were greater (90%, 28% and 8% respectively). Leafless cuttings taken higher up the stem or from branches never produced any roots, even with growth substances.

Pyke[1] described the principles and technique of the so-called I. C. F. A. propagator, which was designed at the Imperial College of Tropical Agriculture in Trinidad for the rooting of cacao cuttings on a large scale. The main principle in this type of propagator is the reduction of transpiration to balance the limited uptake of water by the cuttings, and one important means to that end is the reduction of sunlight to about 8% of its full value.

The reduction in solar radiation helps to keep the temperature in the bins below 30° C, and in the middle of the day, when air temperature in the tropics rises to 33° or 34° C., a wet cheesecloth on the glass lids, cools the bins by evaporation to about 30° C. The intensity of light in the bins corresponds to that below the trees in a full-grown Hevea plantation, which noticed by Roelofsen and Coolhaas[4].

More light cannot be given without raising the temperature to a point injurious to the cuttings. Intensity of light is therefore a limiting factor in this type of propagator, and while cuttings of shade-tolerant species continue to assimilate in the bins, the method is not so successful for light-demanding trees such as Hevea, mango, avocado or sapodilla.

Describing a new method of rooting cuttings of hevea and other trees, Stahel ([5]) mentioned that it was necessary to use two of the doubly covered cheesecloth frames to keep the temperature in the bins down to 30° C.

Without any screen the temperature in the glass covered bins rose to 48-53° C. and was lowered by the wet mosquito net to 41-47° C.

Stahel made attempts to compensate the low light intensity by addition of CO_2 to the air in the bins, and one to six liters of CO_2 per bin per day were administered in fractions every two hours through a hole in the front wall of the bin.

The hevea cuttings were tops of strong nursery plants 2-3 m. high, grown under very light shade, and had 22-24 leaves, of which only about 12 were left on at setting.

They remained in fairly good condition for two or three weeks, but after that showed progressive deterioration. Some leaves turned yellow; the others were killed by fungi. When a few plants began to shed their leaves, the experiment was discontinued.

Stahel writes that even those cuttings that looked normal showed no trace of starch in the wood, though freshly cut material was full of it. No difference in this respect could be detected between the cuttings manured with CO_2 and those from other bins. There seems no doubt that under these conditions the light is insufficient for assimilation of carbon dioxide by hevea at least if the cuttings are from trees grown without shade or under light shade.

Stahel noticed, therefore, that some method has to be found by which the cuttings can be kept at a considerable higher light intensity than the I. C. F. A. propagator afford and that the only convenient way that suggested itself was to use a continuous spray of water over open bins. This would keep the leaves cool both by contact and by evaporation, would provide a permanently saturated atmosphere, and also allow a continuous supply of CO_2 by free ventilation. The question was whether the cuttings could endure a daily rain of 8 hours for weeks in succession.

All the material was cut towards the end of the long dry season and was thus in a resting condition. The cut ends were washed for about an hour in water to remove the latex and then dipped for a few seconds in a 0.5 mgr/cc alcoholic solution of indol-butyric acid.

After 6-8 weeks, 10 of 19 cuttings had one or several roots. 12 terminal cuttings manured daily with CO_2 (½ litre every hour from 8:00 a. m. to 1:00 p. m.) produced a much more abundant callus than the untreated ones, though fewer rooted.

Later trials showed that for cacao less light was desirable than for hevea. When light was reduced by a suitable overhead screen to about 25%, with the spray used from 9:00 a. m. to 5:00 p. m., he found that single-leaf cuttings from a young well-manured tree gave 95% rooting with indol-butyric acid treatment (2 mgr/cc alcoholic solution) and 88% without it. Well rooted single-leaf cuttings hardened easily in half closed bins.

Branch cuttings of sapodilla root only with great difficulty, if at all. But cuttings from vigorous sucker growth gave 40% rooting without growth substance and 90% when treated with a 2 mgr. solution of indol-butyric acid. Watershoots of avocado with similar treatment gave 60% rooting after 12 weeks.

At the University of Miami were started this year experiments with cuttings of avocado and mangos. For avocada soft and ripe wood cuttings from a mixture of one year old seedlings were used, and for mango cuttings the same material from the so-called turpentine, No. 11, and Haden mango was used.

Four plant propagation boxes were made, following the instruction of a paper from Beltsville, March 1946, by V. F. Stoutemeyer and Albert W. Close, "Plant propagation under fluorescent lamps."[7] In two of the four boxes was built bottom heat installation.

Next to these propagation boxes was made a so-called I.C.T.A. propagator with single glass and one in a green house with a possibility of planting the cuttings under double glass.

By covering the glass with newspapers and cheesecloth 75% of the daylight was taken away. In the wooden propagation boxes, as well as in the more or less copied I.C.T.A. propagators, were built pipes with nozzles for continuous spraying.

Graded coconut compost from the City Nurseries in Miami was used as a medium. A. The following cuttings were propagated under single glass:

10 cuttings of avocado from softwood.

10 cuttings of avocado from softwood treated with Hormodin No. 1.

10 cuttings of avocado from ripe wood.

10 cuttings of avocado from ripe wood treated with Hormodin No. 1.

A thin spray was given during full 24 hours.

Under double glass were planted:

10 avocado softwood treated with Hormodin No. 1.

10 avocado ripe wood treated with Hormodin No. 1.

10 Collins mango softwood treated with Hormodin No. 1.

10 Collins mango ripe wood treated with Hormodin No. 1.

A thin spray was given during full 24 hours.

On the 25th of March the frames in the wooden boxes were planted with the following cuttings:

15 mixed cuttings of avocado.

15 mixed cuttings of mango turpentine.

15 mixed cuttings of mango No. 11.

15 mixed cuttings of mango Haden.

Hormodin was used and a thin spray was given during full 24 hours. When the cuttings were taken, the young avocado mango seedlings were brought out of their dormancy period by abundant spraying.

Plants in the tropics or sub-tropics which are in the dormancy period are definitely unsuitable for any form of vegetative propagation.

During my work in Java, one of the great mango nurseries in the East part of the island, with a rainfall of less than four inches in the four driest months of the year, produced yearly over 200,000 mango buddings which were shipped as stump all over the country by parcel post without any loss, and the percentage of buddings that took was over 90%.

It was possible, only, to obtain that result in bringing the nursery under irrigation in the dry season (the so-called winter in Miami).

There is no possibility for successful budding on a commercial scale when the bark cannot be stripped off, and that is only possible when the plants are in full growth or are brought in that condition.

The best growth of the mango develops during the dry season when the trees can be brought out of their dormancy period by irrigation or an abundant water supply is available.

Results: The only results were obtained from ripe wood cuttings after 8 weeks under full 24 hours fluorescent light and a continuous thin spray.

Taking away 75% of the light during the first four weeks has given no results; neither has the bottom heat given any results. With this first trial, there was no difference in rooting capacity between treated and untreated cuttings with Hormodin No. 1.

Most all the ripe wood cuttings, both from avocado and mango, started with callus formation after about four weeks. Roots developed irregularly during the following four weeks with one exception, the Turpentine mango. Haden rooted the best; next, No. 11; and the so-called Turpentine, very slowly. As none of the cuttings of the Collins mango were put under fluorescent light and 75% of the light was taken away by shading the glass cover of the propagation boxes with paper and cheesecloth, none of the cuttings made roots.

Experiments are now under way to find out whether this system of propagation can be used for rubber, tea, coffee.

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PROGRESS OF THE AVOCADO AND LIME INDUSTRY IN THE RIDGE SECTION OF FLORIDA

W. F. WARD

Avon Park

AVOCADO:

The first commercial avocado planting was made in Highlands County in 1920 by J. L. Ivey of Lake Placid. About the same time, some plantings were made in Polk County at several places, among which were some by the Buckeye Nursery near Winter Haven. Several small plantings were made in Polk County during the Twenties but no large plantings were made during that time. Those in Polk and Highlands Counties who wished to plant trees were at a loss as to what varieties to plant, the type of soil to plant the trees on and the care to give the trees after they were planted. Some growers in the area from Miami southward were quite skeptical about avocados being grown that far North and advised the interested parties to come to Dade County to make their plantings. This advice caused those interested to try certain varieties of the Mexican and Guatemalan races which would withstand more cold, so many trees were sold of the Fuerte, Puebla and Gottfried varieties

and lesser numbers of many other Guatemalan varieties. All the growers were groping in the dark and plantings were made on the trial and error basis.

The 32 acre grove planted by J. L. Ivey in 1920 was made up largely of Fuerte, Taft, Cantel, Panchoy, Nimlioh, Winslow, Winslowson, Eagle Rock and Lula varieties furnished by George B. Cellon of Miami. All of these varieties except the Lula were discarded or topworked later.

In 1924 and 1925, the writer made his first planting of 20 acres to avocados, using all varieties planted by Mr. Ivey except the Fuerte and, in addition, planted trees of the Collins, Collinson, Itzamna, Gottfried, Peubla, Trapp, Linda, Hardee and Taylor varieties and a limited number of a few other Guatemalans. In addition, 417 West Indian and Guatemalan seedlings were planted and grown to 9 years of age to see if any especially desirable trees could be developed. Of all the budded or grafted varieties planted, only the Lula and Taylor were finally kept. Of the 417 seedlings, all were finally topworked except one which was named the Avon and is now being propagated for commercial planting since it has many desirable qualities. The grafted varieties were kept until they were 10 years old and careful observations and notes were made. Of 35 Puebla trees kept until 10 years old, all would bloom heavily and set a good crop of young fruit but not a single fruit ever reached maturity. The Nimlioh, Panchoy and Taft were very shy bearers, seldom ripening but a few fruit per tree. The Collins bore heavily but the market did not like the fruit which was of poor quality. The Collinson was a good eating fruit but a little too large and the trees were rather shy bearers. The Winslowson fruited well but could not be kept in cold storage without turning black near the seed and got a bad reputation on the market. All the other varieties tried out except Lula and Taylor had several faults which doomed them to failure. At one time, it was thought the Lula might fail because of its intense susceptibility to avocado scab but after a spray program was worked out for the control of scab, it became one of our best and most profitable varieties.

At this time, our best commercial varieties of avocados are Lula, Taylor, Booth 7, Booth 8, Nabal and Tonnage. One or more good varieties ripening in July and August is quite to be desired since it would lengthen the shipping season.

By 1925, about 50 acres of avocados were growing in Highlands County and by 1949, this had increased to about 530 acres of which 230 acres are in bearing. Polk County probably does not have over 100 acres of good commercial avocado groves at present.

The production of avocados in Highlands County for the calendar year of 1948 was approximately 25,000 bushels or about 110 bushels per acre for all groves of various ages. The crop for the calendar year of 1949 was estimated at 30,000 bushels for the county but the August hurricane blew about 90% of the crop from the trees. The old Futch Grove was carrying a crop of about 250 bushels per acre prior to the storm but suffered a 93% loss of fruit.

From 1890 to 1940 or for 50 years, only one real hurricane passed through the Ridge Area and that was in 1928. In the last 6 years, we have had 5 severe storms which have been quite destructive to avocado plantings and have held back additional plantings.

For the warmer and better protected areas in the south end of the Ridge Section, the outlook is still good and it is expected that the industry will continue to expand slowly. The trees grow larger, produce heavier and have a deeper root system in the Ridge Section than the trees in the Dade County area and if hurricanes do not come too frequently, the industry should remain on a profitable basis.

Limes:

The first commercial Persian lime grove in Highlands County was planted by Charles Townes, Sr., just southeast of Lake Placid on the south side of Saddlebags Lake immediately following the big freeze of 1895. This grove was of about 5 acres and most of the trees were budded on sour orange root with some of the trees being on grapefruit root. I visited

this grove last week and found that about 75% of the trees were still living although they are over 50 years old. Many of the original trunks have decayed but sour orange sprouts which had come out from the old stump or the roots have been budded and the grove continues to bear very well. A large percentage of the trees show signs of gummosis or psorosis but even though afflicted with this disease, they are still bearing. About 20 years ago, the belief was quite prevalent that limes were incompatible with sour orange rootstock and would not do well when propagated on same. This is not borne out by the behavior of the Townes Grove nor by many other groves planted in recent years. About 25 years time elapsed after the Townes Grove was planted before other commercial lime groves were planted in Highlands County. The majority of the groves in Highlands County were planted from 1924 to 1944.

A few years ago, there were many lime groves in Polk County and it appeared that Polk would produce a tremendous amount of limes, however, the freezes in the early Forties damaged trees to such an extent that many growers did away with their groves, later planting the land to oranges and grapefruit. At the present time, the production of limes by various counties ranks as follows: Dade, first; Highlands, second; Polk, third; Hillsboro, fourth. Dade County produces over 75% of the seedless limes in Florida; the Ridge Section about 20% and other South Florida Counties produce the remainder.

The lime trees of the Ridge Section are grown chiefly on lemon root and become much larger in size than those grown on the rocky soils of Dade County. For this reason, from 60 to 70 trees are grown per acre in Highlands and Polk Counties while about 100 trees per acre may be planted in Dade County.

At the present time, Highlands County has about 200 acres of lime trees in bearing and the production of fruit last year was about 27,000 bushel crates, weighing 55 pounds each. From January 1st to October 25, 1949, the Futch Packing House at Lake Placid has handled 27,800 bushel crates of limes from Highlands County with other shippers in the county having handled about 1200 bushels. This makes a total of 29,000 bushels in 10 months for this county and it is expected that approximately 1000 bushels will be picked from November 1st to December 31st. This 29,000 bushels is the production figure for Highlands County and does not include about 3000 bushels from Polk County which have been handled by the Futch Packing House. The average production this calendar year was 145 bushels per acre in addition to some loss from the hurricane of August 26th. The trees range from 4 to 25 years old with an average of about 14 years. In 1948, the production from these same groves was about 140 bushels per acre. The production from 24 acres of my personal groves this year has been 330 bushels per acre from trees averaging about 15 years old. Last year, the average production from these same groves of mine was 300 bushels per acre.

Young groves not yet in bearing comprise about 50 acres in Highlands County. While our production of limes per acre is heavy, the acreage is small and is not increasing fast for the following reasons:

1. Lime trees are more easily injured by cold than the common varieties of orange and grapefruit trees;

2. Considerably more pruning is required due to bark diseases;

3. Limes have to be picked nearly every month of the year and the average citrus grower does not care to take on this additional work.

Most of the lime crop had been picked when the hurricane of August 26th hit the Ridge but nearly all of the remaining fruit was blown from the trees. Defoliation was heavy and the damage from split and twisted limbs was very severe. The highest recorded winds reached 120 m.p.h. in gusts. Practically all groves have been pruned and fertilized since then and recovery is taking place rapidly.

It is expected that for future plantings in the Ridge Area most lime trees will be planted on lemon and Cleo rootstocks. Lime trees on Cleo produce a very high quality fruit. Trees on Cleo stock are slower in growth and do not

bear quite as heavily under 10 years of age as do trees on lemon root but they will eventually attain about the same size and bear equally as well as lemon root trees.

The outlook for limes the next 5 years in the Ridge Area is for slowly increased plantings with profitable operation of the groves.

STROPHANTHUS SARMENTOSUS, A POSSIBLE NEW DRUG PLANT FOR SOUTH FLORIDA

H. F. Loomis

U. S. Plant Introduction Garden

Coconut Grove

The discovery that the wonder drug, Cortisone, used in relief of arthritis and rheumatism, might be obtained more quickly and at less expense from certain plants than from animal products has stimulated an active research for the best botanical sources of the drug. The earliest and still considered the most likely possibility is a West African arrow poison vine with the scientific name of *Strophanthus sarmentosus.* This and related species of the same genus have long been known to medicine as yielding an important heart stimulant, Strophanthin, extracted from seeds gathered in the native home of the plants. Of the 50 or more known species of Strophanthus only one or two from West Africa have been investigated for Cortisone production and of those that have, usually only the parts of the plants used by drug manufacturing companies for extraction of strophanthin have been available. Thus many parts of the plants of some species and all parts of others remain to be tested for cortisone content. Variations in yield of cortisone from different samples from the same species indicate that much is to be learned as to the proper growing conditions for the plants and the best time to harvest and cure the productive part or parts of the plant. Thus it will be seen that a vast amount of investigational work must be done before it can be determined which are the best species for planting, where these are likely to grow well, and the methods to effect yields of cortisone that may eventually justify commercial plantings.

The species of the genus Strophanthus, of the family Apocynaceae, are represented as trees, shrubs and rank-growing vines occurring in tropical Africa, Southern Asia, Malaya and the Philippines. *S. sarmentosus* is one of the better-known species and is a tropical liana or vine climbing to the tops of the trees in its native home, but under cultivation behaving either as a vine, if given proper support, or as a sprawling shrub when grown without support in the open. In full bloom the vine is very spectacular with innumerable funnel-shaped, white or pale cream flowers with a deep purple throat. The petals terminate in striking, long, pendant streamers. The paired pods are 6 or 7 inches long containing the flattened seeds, each of which has a downy tuft of silky hairs at one end much like the common milkweed. It is from these seeds that both strophanthin and cortisone have been extracted.

Up to the present, the demand for Strophanthus products has not been sufficient to cause commercial planting of any of the species. In fact, with one or more of them this has been prohibited in parts of Africa because of misuse of the poisonous parts of the plants by the natives. Thus only wild plants have been involved in the drug trade and it has not always been certain which species were represented or the exact locality from which collections may have come.

When it became known that Strophanthus might be a valuable source of cortisone the President requested the U. S. Public Health Service and the U. S. Department of Agriculture to study all phases of the problem. The former agency has been charged with investigating its chemical aspects while the Department of Agriculture is fostering the

botanical and cultural research. Early in August of this year the Division of Plant Exploration and Introduction of the Department of Agriculture sent a botanist to West Africa to locate all possible species of the genus, collect seed and plant material for propagation and chemical analysis in this country, and to establish stocks of all species in Liberia from which experimental materials may be drawn. Details of all phases of the plant habits and environment are being observed to assist in establishing the various species in suitable locations here and elsewhere. Results of this work already are appearing.

In this country a search has been under way to locate all the plants of this genus that may be growing here as a result of introductions made in the past. A number of mature plants of *Strophanthus sarmentosus*, developed from seeds collected in French Guinea by Dr. David Fairchild in 1927 have been located in Puerto Rico, the Canal Zone, Cuba and several places here in the United States. Among these latter are the U. S. Plant Introduction Garden and the R. H. Montgomery Estate, Coconut Grove, Fla., and a private collection of a grower at Kendall, Fla. Also known are two plants of *Strophanthus gratus* and two of an unidentified *Strophanthus* species at the U. S. Plant Introduction Garden. Although these two latter species fruited some years ago, they have not done so recently and it has not been possible to determine the cortisone content of their seeds.

The mature vine of *Strophanthus sarmentosus* at the U. S. Plant Introduction Garden is from the original 1927 introduction and has grown to very large size, each of its two basal stems having a diameter of six inches. It has flowered profusely, in the early Spring for many years and it has produced a few flowers at other seasons but, like most of the other known plants of this species in this hemisphere of which records have been obtained, it has never fruited. Only the plant at the Montgomery Estate in Coconut Grove, Fla., and one at the Atkins Institute, Soledad, Cuba have fruited and these sparingly. From observations made here as well as in Africa, it seems quite likely that fruiting is dependent on insect pollination of the flowers and hand pollination may be necessary to secure a set of fruit where the insects are not present. Various tests, with *Strophanthus sarmentosus* particularly, indicate that vegetative propagation is relatively simple so that multiplication of any desired strains will not be dependent on a long-time breeding program to produce pure lines of seed. With *S. sarmentosus* all types of cuttings from old wood to the most succulent growing tips and even single leaves with attached chips of stem have been rooted in from ten days to three weeks and it is thought that with the coming of cool weather, when differential temperatures may be obtained, better rooting success may be secured with bottom heat in cutting boxes.

The widespread publicity that has been given in popular and scientific magazines and in newspapers to the possibilities of developing supplies of cortisone from plants, naturally has stimulated great interest among many different groups of people. The desire to make experimental or even commercial plantings has been expressed by many, but thus far the lack of sufficient authentic planting material to supply the urgent needs of the agencies officially designated to conduct the initial investigations has not allowed diversion of seeds or cuttings to others. It has been found that the species of Strophanthus being studied in Africa will not produce seeds there for some months and the amounts that may be obtained then are indefinite. Needless to say, distributions of planting material will be made as soon as conditions of knowledge and supplies of seed, seedlings or cuttings justify, but from present prospects this probably cannot take place until the middle or latter part of 1951.

The performance of the few plants of the several species of Strophanthus that have been grown in southern Florida insures much more intensive tests being made throughout this area at the earliest opportunity. One of the many important features that must be learned here will be how to make the mature vines

set normal crops of seed unless future studies show that other parts of the plants may yield cortisone more economically. It is upon satisfactory answers to questions such as these, and others that have been indicated, that the future of Strophanthus planting here lies.

DIPPING PINEAPPLE PLANTING STOCK FOR MEALYBUG CONTROL

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Planting stock intended for starting beds of pineapples is likely to be infested with the pineapple mealybug, *Pseudoccus brevipes* (Ckll.). Infested plants produce some fruit, but will grow more rapidly, be more thrifty and productive if the mealybug is controlled. One of two choices may be made in starting pineapple plantings. Stock may be planted with the mealybug infestation present or it may be treated so that it is non- or but lightly-infested.

One method recommended for treating stock used for starting new beds is fumigation by methyl bromide, as reported by Osburn (1945). This method gives apparently perfect control of the mealybug. A gas-tight fumigation chamber, however, is a necessity, requiring the outlay of some money for one that is satisfactory. This expense may be borne readily by those having large plantings, or perhaps by those selling the planting stock. Those having small beds or very small acreages, however, may wish to use some other method, even one that does not give perfect control.

Dipping and spraying the planting stock are other methods that offer possibilities. These methods were tried by Carter (1931) in Hawaii, who tested oil emulsions, rotenone, and nicotine sulfate materials as dips or immersions, and as sprays. Although his two percent oil emulsions gave the best results, they were but partially effective. He reported that there was always some injury or danger of injury to the plants where oil emulsions were used. The advent of DDT and subsequent new insecticides opened new possibilities for pineapple mealybug control. Reports on experiments conducted in Florida in which these materials were tested have been given by Osburn (1949), and Wolfenbarger and Westgate (1947), and Wolfenbarger (1948, 1949). That phase of testing the insecticides at the Sub-Tropical Experiment Station as dips for planting stock[1] is herein reported. The tests are reported in the chronological order in which they were conducted.

July 1946. Eighty-eight rather small sucker plants were divided into lots for eight treatment materials, including the check. This gave 12 plants for each of the seven dip treatments, and for the check. The 12 plants were further divided into lots so that there were three lots of four plants each. This provided four plants to be dipped for 0.5 minutes, four for 3.0 and four for 10.0 minutes, in each material. A week after the plants had been treated they were examined to determine treatment effects. The leaves were stripped from each plant to expose any mealybugs present. The results of the treatments, by materials, all 0.5, 3.0 and 10.0 minute immersions included, average number of living mealybugs present per plant, and percentage control are summarized in Table 1.

Effective control was obtained by all of the newer insecticides. Although the plants were sacrificed so that no treatment effects as plant injuries were determinable, later tests disclosed that the concentrations tested were injurious to the plants or were impractical for use.

In order to show the effect of time spent immersed in the dips all data were summarized

[1] Acknowledgment is made to the Miami Pineapple Plantations as the source of much of the planting stock used in the various tests.

TABLE 1. TREATMENT MATERIALS, CONCENTRATION USED, AVERAGE NUMBER OF LIVING MEALYBUGS PER PLANT, AND PERCENTAGE CONTROL

Treatment material, and concentration tested	Avg. No. living mealybugs per plant	Percentage control
DDT, 50% w.p. micronized [1], 1% active ingredient	0.6	98
DDT, 25% emul. [2], ½ of 1% active ingredient	0.5	98
Benzene hexachloride, 6% gamma-isomer [3], 6/10 of 1% gamma-isomer	.08	97
Nicotine sulfate, 40% 1:800	5.8	79
Oil, Volck, 2%	2.2	92
Check	27.3	....
Syntone, rotenone derris extractive 1:800	16.2	41
Chlordan, 81% emul. [4], 4/10 of 1% active ingredient	1.1	96

[1] Secured from Pennsylvania Salt Company
[2] Secured from Rohm and Haas Company
[3] Secured from E. I. duPont de Nemours Company
[4] Secured from W-Z Laboratories

under 0.5, 3.0, or 10.0 minute classes, as follows:

Minutes immersed	0.5	3.0	10.0	Check
Avg. No. living insects per plant	1.4	6.5	3.7	27.3

The difference in length of time the plants were immersed are considered as having no significance. Immersions of 30 seconds have since been considered a sufficient length of time for dipping the plants.

September 1946. Fifty-six pineapple tops moderately infested with mealybugs were divided into lots of equal numbers for seven treatments. A fumigation treatment was used in this test. Methyl bromide was placed in a shallow pan and sealed with the plants in a gas-tight, drum-like, metal chamber, at the rate of two pounds per 1,000 cubic feet for two hours, at a temperature of about 80° F. The dip treatment materials were placed in five-gallon cans into which the plants were immersed. Five days after the treatment date, five basal leaves were removed from each plant to note any living mealybugs. The results are summarized in Table 2. All dip treatment amounts are given as the rate per 100 gallons of water; all included one pint of V-30 wetting agent per 100 gallons of water.

The methyl bromide fumigation gave perfect control of the mealybug. All dip treatments gave some control. The phosphatic insecticide Vapotone gave the best results of the dip treatments. No treatment appeared to have caused any plant injury.

Parathion, another phosphatic insecticide, became available after the above tests were made. Early tests under field conditions had indicated its promise in mealybug control.

June 1949. A large scale test was conducted in cooperation with Mr. Dan Radebaugh of Sebring. Methyl bromide fumigation at two pounds per 100 cubic feet, for two hours in a 105 cubic-foot metal fumigation chamber using a water sealed top, with a 16-inch fan to move the fumigant about in the

TABLE 2. TREATMENT METHODS, MATERIALS, RATES OR AMOUNTS OF MATERIALS, AVERAGE NUMBER OF MEALYBUGS PER PLANT, AND PERCENTAGE OF CONTROL OBTAINED

Method	Material	Rate or amount	Avg. No. mealybugs per plant	Percentage control
Fumigation	Methyl bromide [1]	2 lbs./1000 cu. ft./2 hrs.	0	100
Dip	Vapotone [2]	1 pt.	9.4	68
Dip	Vapotone [2]	1 qt.	5.7	78
Dip	Vapotone [2]	2 qts.	5.1	81
Dip	Selocide [3]	1 pt.	10.4	60
Dip	DDT, 15% plus Lethane 30% [4]	1 qt.	9.2	65
	Check		26.2	....

[1] Secured from Dow Chemical Company
[2] Secured from California Spray-Chemical Corp. The Vapotone was labeled at that time as 50% HETP content
[3] Secured from McLaughlin Gormley King Company
[4] Secured from Rohm and Haas Company

TABLE 3. NUMBER OF PINEAPPLE MEALYBUGS ON TREATED PLANTS

Treatment	No. plants examined	No. living mealybugs	No. dead mealybugs
Methyl bromide fumigation	7	0	66
Parathion dip	11	4	117
Oil emulsion dip	5	35	36

chamber, was one of the treatments. Parathion, one pound of 15 percent wettable powder per 100 gallons of water, and two percent oil emulsion as dips were two other treatments. A combination dip of two percent oil emulsion and one pound of parathion per 100 gallons of water was another treatment used to treat a smaller number of plants. The Natal variety was used in the fumigation, and the parathion dip; the Smooth Cayenne was used in the oil emulsion dip and in the oil combined with parathion. Ratoons, slips, tops, and young plants were used in this test as planting stock for starting new beds. About 1000 plants were estimated to have been treated by fumigation, 900 by dipping in the parathion dip, 400 in the oil emulsion dip, and 100 in the parathion-oil emulsion combination dip. The plants were set in the field a week after the treatments. Observations were made on a few plants the next day following the treatments. The results are presented in Table 3.

The fumigation has given complete kills of the mealybug. Living mealybugs, however, were still found on plants immersed in parathion and in the oil emulsion, in the short time after the treatments.

One month after the treatments, ten plants were removed from each of four areas in the beds from each treatment for examination. The lower five leaves were removed from each plant to observe any living mealybugs present. No living mealybugs were found on any immersion or fumigation treated plant. A total of 108 living mealybugs was counted on 40 untreated plants. The pineapple mite, *Stigmaeus floridanus* (Banks), however, was found on the fumigated as on the dipped plants of all treatments. No plant injury was observed as a result of any treatment.

August 1949. Thirty mealybug infested plants were divided into five lots for different dip treatments. Seven days after the treatments, the leaves on the plants were removed one by one in search of living mealybugs. The results are presented in Table 4.

The six plants in each treatment were quite uniform as to insect infestations; hence, the results in Table 4 are considered to have faithfully demonstrated the treatment effects. Although two pounds of parathion gave the best control, the one pound concentration was very effective. Neither a regularly used amount of DDT, two pounds of 50 percent wettable powder per 100 gallons of water combined with a reduced amount of oil, nor a two percent oil emulsion came near to the control obtained with parathion.

SUMMARY

Methyl bromide fumigation gave perfect

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TABLE 4. PINEAPPLE PLANT DIP MATERIALS, AMOUNT OR CONCENTRATIONS, AVERAGE NUMBER OF LIVING MEALYBUGS PER PLANT AND PERCENTAGE CONTROL

Material	Amount per 100 gallons water or concentration of active ingredient	Avg. No. live mealybugs per plant	Percentage control of insects
Parathion, 15% powder	2 lbs.	1.8	99.6
Parathion, 15% powder	1 lb.	2.8	99.4
Oil Volck 90, plus DDT, 50% w.p.	1% plus	61.8	85.7
Oil emulsion, Volck 90	2 lbs.	.....	85.7
Check	2%	432.7	.....

control of the pineapple mealybug on planting stock used for starting new beds. Tests of several different insecticides showed that dips containing one pound of 15 percent wettable parathion powder gave excellent mealybug control, with safety to the plant. No treatment tried gave perfect control of the pineapple red mite.

THE POSSIBILITIES OF 2, 4-D FOR THE CONTROL OF POST-HARVEST DECAY IN FLORIDA LIMES

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Coral Gables

The present work on the use of organic fungicides for the control of citrus rots was begun at the University of Miami a year ago. Various organic compounds were tested for the control of stem end rot of oranges. With the end of the orange season last summer, the work was continued on Persian and Idemore limes with the addition of 2, 4-D to the list of compounds tested.

Kessler and Allison[1] obtained good rot control on California lemons while using 2, 4-D for holding the buttons on fruit in storage. Steward and Hield[2] and others[3] in California have been using 2, 4-D sprays up to 64 P. P. M. for increasing fruit size and prevention of preharvest drop on oranges and grapefruit.

MATERIALS AND METHODS

The dipping tests were set up in three different experiments. In the first test, the compound which gave the best results in the orange tests were tried on limes. They included: 3% thioacetamide, 2½% 2-aminopyridine, 5% thiourea, 3% thioacetanilide and 1% O-amino phenol. The sodium salt of 2, 4-D was used in concentrations of 100, 500 and 800 P. P. M. as sodium salt. The limes were divided into 18 lots of fifty limes each. Each lot was divided into 2 replications. Two lots were treated with each compound and each concentration of 2, 4-D by dipping the limes into a water solution for five minutes. The limes were then removed, drained and placed on trays for drying and storage at room temperature (about 80°F.) for five weeks. After the fruit was dry, the limes in one lot of each treatment were wrapped in 20 guage vinylite film. Two untreated lots, one wrapped and one open, were retained as checks. The limes used in the first and second tests were packinghouse number one fruit.

In the second test, 2, 4-D alone was used in concentrations ranging from 200--2400 P. P. M. and 4000 P. P. M. In this test, 9 lots of 100 limes were divided into 4 replications. The same dipping and drying methods were used but none of the fruit was wrapped. One lot was retained as a check. Storage was at room temperature on trays.

The third test including wrapping and refrigerated storage along with various concentrations of 2, 4-D ranging from 600-2000 P. P. M. Number three limes were used in this test. The fruit was divided into 6 lots of 150 limes each. Six replications of 25 limes each in each lot were treated in 2, 4-D dips as described above. After drying overnight, 3 replications of each lot were wrapped with 20 gauge vinylite. One wrapped and one open replication was stored under refrigeration at 48°F. The rest of the fruit was stored at room temperature (about 75°F.) for 3 weeks. A check lot received identical treatment but was not dipped.

Along with the dipping tests, a preliminary test of 2, 4-D as a spray on lime trees was tried. Twelve Idemore lime trees, 8 years old, were divided into three lots of four trees each. Three trees of each lot were sprayed with a water suspension of the butyl ester of 2, 4-D in concentrations of 16, 32, and 64 P. P. M. as butyl ester at the rate of 3 gallons per tree. One tree of each lot was left unsprayed as a check. The spray was applied from a Hudson pressure tank, 3 gallon capacity, using a fine fan nozzle. It is estimated

that approximately ½ gallon of the applied spray was lost in run off and wind drift. The age of fruit on the trees ranged from bloom to maturity. Flowers present at the time of the spraying were tagged. The trees were sprayed on the 11th of August 1949. Observations were made at weekly intervals and on October 14th, four boxes of fruit were picked from the 12 trees. One box was picked from the three check trees and one box was picked from the three sprayed trees in each lot. The fruit was first graded as to color and then as to commercial grades 1, 2, or 3. The average weight per lime was obtained by weighing 90 limes picked at random from each box.

Experimental Results

The result of the first dipping tests are given in Table 1 below. 2, 4-D did not materially reduce rot in the non-wrapped fruit in concentrations of 100 or 500 P. P. M. At 800 P. P. M. 2, 4-D the rot in the non-wrapped fruit was reduced from 22% in the controls to 4%, and in the wrapped fruit from 50% in the controls to 10%. Thiourea was the only other compound tested which gave good control of decay in both the open and wrapped fruit, reducing the rot to 2% and 12% in each case. The fruit treated with 2, 4-D retained a green color throughout the test and the buttons remained green on the fruit presenting an appearance that the public has learned to expect in fresh limes. The wrapped fruit treated with 2, 4-D showed considerable growth in the albedo just below the button so that the usual button depression was pushed out to the extent of ¼ inch in some instances. Microscopic examination of this tissue showed that the growth was due to an increase in the number of cells rather than to cell enlargement.

TABLE 1
The combined percentage decay of Persian Limes from 2 replications of each treatment after 5 weeks storage at room temperature.

Treatment	PERCENT DECAY Not wrapped % of 50 Fruit	Wrapped % of 50 Fruit
Check	22	50
100 PPM 2, 4-D	14	8
500 PPM 2, 4-D	14	18
800 PPM 2, 4-D	4	10
3% Thioacetamide	28	30
2½% 2 Aminopyridine	14	12
5% Thiourea	2	12
3% Thioacetanilide	44	54
1% 0 Amino phenol	12	22

The second test on unwrapped fruit was inconclusive because of the lack of rot present in the check lot. The incidence of rot did, however, increase considerably in the lots treated with 2400 P. P. M. and 4000 P. P. M. 2, 4-D. The results of the third test are summarized in Table 2. In the refrigerated limes there was no difference between the controls and the treated fruit. Refrigeration held the rot to a minimum in all cases.

In the fruit held at room temperature, 2, 4-D was not as effective in reducing the incidence of rot as in the first test. The greatest difference was in the treatment at 1200 P. P. M., 18 percent of the treated fruit rotting compared to 45% in the checks. Wrapping the limes in vinylite film did not reduce the percentage of rot, but the fruit remaining was in better condition than that not wrapped.

Results of the spray test on lime trees are given in Table 3 below. The spray at 32 P. P. M. gave the best results increasing the number of all green fruit from 47.7% in the checks to about 69% in the sprayed trees. The percentage of number one fruit from the trees sprayed with 32 P. P. M. 2, 4-D was 55% compared to 38% from the unsprayed trees. The percentage of all green fruit and number one fruit was greater on the trees sprayed with 16 & 64

TABLE 2. THE COMBINED PERCENTAGE DECAY OF PERSIAN LIMES CONCENTRATION OF 2,4-D DIPS AFTER 3 WEEKS STORAGE AT ROOM TEMPERATURE AND 48° F.

CONCENTRATION as n a salt	Refrigerated 48° F Open % of 25 Fruit	Wrapped % of 25	Total % of 50 Fruit	Room Temperature 75° Open % of50 Fruit	Wrapped % of 50 Fruit	Total % of 100 Fruit
Check	0	4	2	40	50	45
600 RPM	4	0	2	24	20	22
800 PPM	4	4	4	32	32	32
1200 PPM	8	0	4	16	24	18
1600 PPM	0	0	0	26	32	29
2000 PPM	0	0	0	32	22	25

TABLE 3. THE PERCENTAGE OF IDMORE LIMES OF VARIOUS GRADES FROM TREES SPRAYED WITH 2, 4-D IN VARYING AMOUNTS

Concentration of 2-4-D Spray as butyl ester

Description of Fruit	16 P.P.M. 234 Fruit	32 P.P.M. 286 Fruit	64 P.P.M. 273 Fruit	Check 237 Fruit
COLOR				
All Green	59.40	68.88	61.90	47.68
White-Splotched	29.06	18.88	17.95	27.00
Yellowing	11.54	12.24	20.15	25.32
GRADE				
No. 1	42.31	55.24	27.98	38.40
No. 2	31.20	24.48	20.88	26.58
No. 3	26.49	20.28	31.14	35.02
Av. Wt./Lime	109 g	105 g	104 g	116 g

P. P. M. than on the check trees. One of the main factors present in this fruit which reduced the grade of a given lime was yellowing, due to sunburn and minor wind damage. In the trees sprayed with 16 & 32 P. P. M. 2, 4-D, the fruit in this category was at a minimum.

On August 19th, the sprayed trees experienced winds up to 50 M. P. H. due to the tropical storm which entered the mainland near West Palm Beach. There was no noticeable difference in the number of dropped fruit under any of the sprayed trees.

The 2, 4-D sprays did not have any apparent effect on the trees except for minor leaf curl on very young leaves. The curled leaves developed normally and the tree showed no outward signs of having been sprayed after two weeks. The broadleaf weeds around the trees were curled noticeably one week after spraying, but recovered within four weeks. Fruit set and flowering was not stimulated by the spray. The fruit from the sprayed trees was slightly smaller than that from the checks. The time of spraying when most of the fruit on the trees was nearing maturity probably accounts for the lack of increase in fruit size.

Conclusions

The results of these tests on the possible use of 2, 4-D for the control of post harvest decay of Florida limes is not too conclusive, but show possibilities that should be investigated further. Where number one fruit was used in tests concentrations of 2, 4-D up to 2000 P. P. M. were effective in controlling decay where the check replications had enough decay present for comparison. In the test using number three fruit already disposed to rot 2, 4-D was not too effective. Though in all cases the percent rot in the treated fruit was less than in the checks, the question arises as to the significance of this difference. Only further testing can answer this question. The addition of 1000-2000 P. P. M. sodium salt of 2, 4-D to the wash water in the packing house could be done at negligible cost and may prove effective in increasing the keeping quality of number one fruit. Number three fruit had best be utilized as soon as possible.

The preliminary test of spraying lime trees with 2, 4-D shows some possibilities in reducing the loss from yellowing of fruit due to sunburn and minor wind damage. Further tests should be conducted using sprays from the time of flowering up to maturity. Experience in the use of 2, 4-D in California has shown that such sprays may be effective in increasing fruit size, preventing pre-harvest drop and increasing the percentage of number one fruit.

In conclusion, we would like to extend our thanks to Mr. David Light of Perrine, Florida, for the use of his grove for the spray tests and to the Florida Tropical Fruit Growers Association for supplying us with all the limes used in the dipping tests.

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THE CULTURE OF THE LYCHEE

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INTRODUCTION

For many centuries the lychee has been cultivated in China and esteemed as the king of all fruits; but it was unknown or neglected outside of China until the 19th century. This was largely due to the fact that lychee seeds are very short-lived. If not given special treatment, they lose their viability within a few days under ordinary conditions. In the past century the lychee has been introduced to Java, India, Cuba, the Philippines, Australia, Hawaii, South Africa, California and Florida. This little known fruit has gradually established a new home in the tropics and in subtropical regions outside of its native home, and is now grown on a commercial scale in some of these countries.

Only Kwantung, Fukien and Szechwan provinces grow the lychee in China. The Canton district of Kwantung is an important lychee center and perhaps the one best known to the world, but the most extensive production of lychee fruit is in Fukien, around Foochow, Hinghwa, Chuanchow and Changchow, among which Hinghwa has been most famous from ancient times until the present time. The Chen variety of lychee which the Rev. Mr. Brewster introduced from Hinghwa to this state in 1907 is the one my ancestors began cultivating many centuries ago. Mrs. Brewster was my English teacher in high school, and she still lives in Hinghwa. Tsai Hsiang and Sung Kao, who wrote the classical monographs on the lychee in the 11th century, were natives of my district. I have been intimately familiar with lychee growing from my earliest years. With this background and training, I can hardly fail to know something about lychee culture. In recent months I have received many letters from people in different parts of this state, asking me about the history and culture of the lychee. In this paper I have tried to bring together as much information as possible on these subjects, in hopes that it may be helpful to those who are developing a lychee industry in Florida. It is not possible in a short paper to give a complete discussion of an industry as complex as lychee growing in China today, but it may be of value to state some basic principles.

HISTORY

It is generally agreed that the lychee is native to South China, but the exact area is not known. I have studied many old Chinese writings about the lychee without being able to determine its exact origin. It is recorded in ancient Chinese history that the emperor Wu Ti, about 100 B. C. conquered the Nan Yueh, a small nation about where Tonkin now is. He transplanted hundreds of lychee trees thence to his capital at Chang An (the modern Sian) in Shensi province, and built a palace called Exalted Lychee Palace. In the next century the emperor Yung Yuan established fast runners every 5 miles to carry lychee fruits to Chang An from Kwangsi province, next to Tonkin, a distance of some 800 miles over mountains and rivers. In the 5th century A. D. the favorite concubine of the emperor Teng Pao was very fond of lychees. These were first obtained for her from Pei Chow in nearby Szechwan province (near Chunking), but it was learned that much better quality fruit was grown near Canton, and again fast runners carried fresh lychees some 800 miles as tribute each year. In the 11th century the capital was moved from Chang An to Ling An in Chekiang province, near Hangchow. This is the province next to Fukien, and about this time the Chen Purple and Sung Fragrant lychees of Hinghwa begin to be recorded as outstanding. It seems clear, therefore, that culture was first established near the border between China and Indo-China, and spread next to the Canton area and later into Fukien province. The lychee has not yet been found in truly wild form. The first Chen ancestor settled in Hinghwa around 400 A. D., and by the 11th century the Chen Purple lychee was

already famous, with some trees reputed to be 300 years old. Most of the ancient trees have been cut down, but there are still two trees of very great age at Hinghwa, one being nearly 6 feet in diameter and 75 feet high.

Natural Requirements

The lychee is adapted to the warm subtropics, thriving best in regions of brief winters with little frost and long hot summers with high humidity. Hinghwa is at latitude 25° N, about like Homestead. There is much fog in February and March, and rain or cloudy weather is common during April and May, so that one may not see the sun for a month or more. The lack of this type of spring weather in Florida is probably responsible for the tip-burn so often seen on lychee leaves here. A mature lychee tree about 100 years old with strong branches and deep roots, whose shade covers a quarter-acre, can endure considerable cold without injury. A heavy frost will only kill it back a little at the twig tips, and it will still blossom and fruit in spring. A young tree is, of course, much more sensitive, and the same heavy frost would kill it to the ground. The Chinese lychee grower burns straw under his young trees to protect them from cold. I have seen temperatures down to 9°F. in lychee orchards, with heavy snow on the ground (a most unusual sight in Hinghwa), and under these conditions the mature trees were killed back several feet. They did not bear again for two years, but were not permanently injured. In fully dormant condition mature trees have endured 11°F. with little injury. The winter temperatures at Gainesville are not so low as at Hinghwa, and I was much surprised to be told that it is too cold for lychees there. Later I understood that it is not consistently cool enough in North Florida for lychee trees to become and remain fully dormant.

Heavy rains during blooming are harmful, but during the period of fruit development, from April to June, it is essential to have abundant soil moisture. These are months of good rainfall in Fukien and Kwantung provinces, and in addition the trees are commonly grown along canal banks or on the edge of rice fields. A location with 4 or 5 feet of alluvial soil of high humus content, underlaid by a heavy clay, is best for both vigor of tree and quality of fruit. As we grow it at home, the Chen Purple lychee has 90% of its fruit with partly developed or shrunken seeds, which we call "chicken-tongued." This same variety here in Florida produce almost 100% of fully developed seeds, perhaps because of dry, sunshiny weather during pollination here.

Propagation

For a thousand years it has been the custom to propagate the best lychee seedlings by air-layering, a process often called "Chinese layering." A ring of bark is removed from a lychee branch about 1 to 2 inches in diameter, and the wound is covered with a mixture of mud and straw. This is held in place by wrapping of burlap and kept moist until roots have developed in the mud ball. The branch is then cut off just below the ball and set in the ground under the shade of mature lychee trees, where it remains for a year before being set out in a new planting. Various devices are used to maintain a proper moisture content in the ball during rooting. Air-layering is usually started in spring as soon as the tree begins active growth, and it takes about three months for a sufficient root system to develop to support the branch independently. This ancient method has been much improved by Col. W. R. Grove here in Florida, using sphagnum moss enclosed in a plastic film to eliminate need for periodic moistening of the rooting medium.

Lychee seeds are very short-lived, but germinate readily for several days after being taken from the ripe fruit. They are rarely used for propagation because of the uncertainty as to the kind of fruit they will produce, and also because seedling trees are very slow to bear. Some may bear at 5 years of age, but others may be 25 years old before they bear.

Grafting is rarely practiced with lychees in China. Many people, both in and out of China, have been impressed with the vigor of growth made by the longan, which is a close relative of the lychee, and have attempted to use it as

a root-stock. So far as can be learned, none of these attempts has been permanently successful.

Grove Management

Lychee trees are usually planted along canal banks and on the edge of rice-fields in the lowlands in China, highland plantings being rare. At planting, a considerable amount of well rotted manure or canal mud is placed in the hole under the tree. Young trees are fertilized heavily with chicken or duck manure, and night soil is applied several times a year. Mature trees are usually fertilized only twice a year—in early spring and after harvest in summer. From 100 to 200 lbs. of night soil are applied to each tree in a shallow trench dug just beyond the drip of the tree. Soybean cake or peanut meal may be used at 5 to 10 lbs. per tree, or mud from canals and fish ponds may be piled under the tree as fertilizer. Chemical fertilizers are never used on lychees in China.

Neither pruning nor thinning of fruit is commonly done to lychee trees, although both practices are regularly used on longans. Lychee fruits are harvested by clipping the clusters with part of the twigs bearing them, and this provides a mild degree of pruning.

The Crop

A layered tree frequently flowers the first year after setting out, but any fruit set the first or second year should be removed. By the third year a few pounds of fruit may be allowed to set, and by the fourth year the tree should be able to carry what it sets safely.

The lychee may continue to bear for centuries, but usually it is most productive from 40 to 100 years of age. A crop of 200 to 600 lbs. is commonly produced by matures trees in good condition, while exceptional trees may bear up to 2000 lbs. The yield is greatly affected by climatic conditions, being seriously reduced by severe cold, by heavy rains continuously for several days in the middle of the blooming season, or by a typhoon during the period between bloom and harvest.

The earliest varieties mature in May and the latest ones in August, but the bulk of the crop ripens in June and July. After harvest, the fruits lose their bright red color within a few days, unless precautions are taken to keep humidity very high around them. In ancient days lychees were packed in a section of green bamboo sealed with clay for transport by runner from Hinghwa to Pekin as tribute, and today some merchants still ship to distant market in this way. Lychee fruit seems well adapted to quick freezing. I have eaten fruits which after being frozen for two years still had good flavor.

The majority of the lychee crop in China is dried, producing what are mistakenly known as lychee "nuts." Drying is done either by exposure to the sun for several weeks, or by use of a brick stove. Fruit dried in the sun brings the better price. It takes 4 lbs. of fresh fruit to make 1 lb. of "nuts."

In recent years quite an industry has developed in China for preserving lychees by canning in sirup. Over 3,000 boxes of canned lychees were exported from Fukien province two years ago. A good portion of the crop is also used to make wine. Minor quantities of fruit go into making lychee sauce, spiced lychee, sweet pickled lychee and preserved lychee.

Pests

One of the stink bugs (*Tesaratoma papillosa*) is the most common and destructive insect pest of lychees in China. It sucks the sap from tender twigs, often killing them, and causes much dropping of young fruit. In 1934 the lychee crop of Hinghwa was completely destroyed by this bug, and during the following winter we collected four tons of adult bugs and burned them with kerosene. No spray has been effective thus far, but various parasites help to keep it in check somewhat. Jarring the trees in winter and collecting the fallen bugs in a bucket of kerosene is the most effective means of control.

There is a small moth (*Acrocercops cramerella*) whose larvae eat developing seeds and the pith of young twigs, causing loss of young fruits and new shoots. It is partly checked by a small wasp parasite, and partly controlled by burning in winter all leaves which have fallen.

A small mite (*Eriophes* sp.) closely related to the citrus rust mite, attacks the leaves and causes small wart-like galls on the upper surface, while the under side becomes hairy. Eventually the infested leaves are of little value to the tree. Nicotine sulfate controls this mite.

Minor pests include a small June-bug closely related to the blossom anomala which attacks avocados and mangos, a web caterpillar, and a bark borer with habits akin to those of the peach tree borer.

Varieties

More than 100 varieties of lychee have been described in the three ancient treatises on lychee culture in Fukien, Kwantung and Szechwan provinces respectively, but many of the names are probably synonymous and others may no longer be represented in cultivation. No modern descriptions of varieties are available for the most part. Only a few varieties are grown in Hinghwa area, and these are briefly characterized here.

Chen Purple is the most famous variety in Hinghwa and is the same as the variety grown in Florida as Brewster. It ripens from July 15 to August 15 and is very good quality. The shell of the fruit is very rough with sharp points.

Red Jade Hall is another variety commonly grown, with some trees over 500 years old. It ripens in late June and early July and is good quality. The shell is rough but without sharp points, and similar to Chen Purple in size but more rounded.

Mid-Autumn Red is a variety of great vigor, making large trees, whose fruits are oval and have smooth shells. They ripen in late July and are sweet but acidulous, of excellent quality.

Fire Mountain is the earliest variety, maturing in late May, and is rather rare. The fruits have thin yellowish flesh, somewhat sour, and sell only because no other variety is yet in season.

Black Leaf is a variety introduced in 1910 from Canton and is very rare. The quality is excellent, the flesh fragrant and sweet.

Hanging Green is another Cantonese variety introduced to Hinghwa long ago, but is also very rare there. The delicious fragrant fruits are mostly used as gifts.

Ten other varieties of less importance are cultivated in Hinghwa.

PACKAGING AND STORAGE OF MANGOS AND AVOCADOS

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Coral Gables

The information on packaging of mangos and avocados presented here is a report of the investigations completed to date at the Tropical Plant and Food Research Center of the University of Miami. It is presented at this time in answer to numerous requests by individuals interested in the progress of this investigation and should not be interpreted to mean that we have arrived at final conclusions with regard to the packaging materials to be used. Before such conclusions can be reached, it will be necessary to further investigate the factors responsible for the pathological and physiological breakdown which occur both in mangos and avocados during storage. The following information does show clearly, however, that a number of wrapping materials will retard ripening and moisture loss from these fruits during storage.

Mangos

The work done during the 1947 and 1948 seasons was directed at determining the effectiveness of different wrapping materials in the retardation of moisture loss and rate of ripening of Fascell and Haden mangos. During the 1948 season, the effect of storage temperature on the storage life of mangos wrapped in a number of materials was investigated.

TABLE 1. EFFECT OF VARIOUS WRAPPING MATERIALS ON THE KEEPING QUALITY OF FASCELL MANGOS STORED AT ROOM TEMPERATURE[1] 1947

Wrapping Material	Percent Loss in Weight After Days					Average Stage of Ripeness After days				
	2	3	5	7	12	2	3	5	7	12
No wrapper	2.51	3.88	5.52	9.08	.....	Firm	Soft	Soft	Overripe	
Pliofilm 20ga N1	0.28	0.69	0.98	1.41	2.10	Unripe	Firm	Firm		Soft
Pliofilm 75ga PF	0.69	1.15	1.82	2.79	3.65	Unripe	Unripe	Firm	Soft	
Pliofilm 75ga NF	0.41	0.85	1.33	2.62	3.71	Unripe	Unripe	Unripe	Firm	
Sylphwrap 300ga Pl	2.27	3.74	5.47	7.50	.....	Firm	Soft	Soft	Soft	
Cellophane 300ga MSAT	0.27	0.75	1.15	1.87	2.71	Unripe	Unripe	Soft	Soft	
Vinylite 20 ga P9V	0.72	1.20	1.67	.....	4.74	Unripe	Unripe	Firm	Soft	
Cellophane Exp. 148	1.64	2.74	3.35	2.78	10.65	Unripe	Unripe	Soft	Soft	
Sylphwrap 300ga PB6DS	0.73	1.38	2.06	.....	5.77	Unripe	Unripe	Firm	Soft	

[1]Room Temperature 75-85°F.

The results of both years' investigations are summarized in Tables 1, 2, and 3.

It is evident from these results that considerable differences exist with regard to the effectiveness of some of the wrapping materials in retarding the loss of moisture and rate of ripening. The prominence of both pathological and physiological breakdown in these fruit directed attention toward the need for additional research in this field.

Among the numerous factors which effect the storage life of fruits is that of storage atmosphere. Since fruits, when placed in storage are still living, they continue to respire utilizing oxygen and releasing carbon dioxide. In addition to the respiratory gases, ethylene and possibly other gases are also evolved. It has been known for years that ethylene gas increases the rate of ripening of fruit and more recently it has been found that storage scald of pears and apples is due, at least in part, to the accumulation of such gases. Numerous methods of control of this physiological breakdown have been investigated, including the use of mineral-oil wraps, shredded oil paper, more adequate ventilation, and more recently activated carbon filters have been used to absorb these gases. The latter method of atmospheric purification has met with considerable success in the storage of apples and pears[3 4].

In view of the high percentage of physiological and pathological breakdown which were noted, both in those fruits which were wrapped and those which were not wrapped in 1947 and 1948 experiments, it was deemed advis-

TABLE 2. EFFECT OF VARIOUS WRAPPING MATERIALS AND DEGREE OF RIPENESS ON THE KEEPING QUALITY OF HADEN MANGOS STORED AT ROOM TEMPERATURE[1]—1948

Wrapping Material	Initial Degree of Ripeness	Percent Loss in Weight After Days				
		4	7	11	14	18
No wrapper	Green	5.01	8.23	12.29	14.54	.....
Vinylite 20 ga P9V (Chem treated)	Green	1.38	2.38	4.05	5.63	.....
Sylphwrap 330 ga PMB 6 CSX	Green	1.18	2.17	3.57	4.84	.....
Cellophane 300 MSAT 86	Green	0.54	1.37	2.36	3.27	.....
Aluminum Foil .00035	Green	0.75	1.47	3.95	3.28	.....
Lumarith 100 ga P-912	Green	5.52	6.38	10.11	13.54	.....
Pliofilm 100 ga (Stretch-wrapped)	Green	1.25	2.07	3.29	.....	.....
Pliofilm 75 FF	Green	1.21	2.07	3.61	4.39	.....
No wrapper	Firm	1.16	2.28	3.27	4.17	5.21
Vinylite 20 ga P9V (chem treated)	Firm	0.18	0.57	0.83	1.02	1.25
Sylphwrap 330 ga PMB 6 CSX	Firm	0.13	0.44	0.78	1.06	1.29
Cellophane 300 MSAT 86	Firm	0.11	0.28	0.46	0.70	0.93
Aluminum Foil .00035	Firm	0.18	0.34	0.50	0.67	0.80
Lumarith 100 ga P-912	Firm	0.71	1.47	2.19	2.98	3.60
Pliofilm 100 ga (Stretch-wrapped)	Firm	0.22	0.57	0.79	1.00	1.20
Pliofilm 75 FF	Firm	0.27	0.59	0.59	1.08	1.28
No wrapper	Beginning to Soften	0.97	2.02	2.85	3.79	4.57
Vinylite 20 ga P9V (Chem. treated)	Beginning to Soften	0.29	0.70	0.98	1.26	1.51
Sylphwrap 330 ga PMB 6 CSX	Beginning to Soften	0.20	0.62	0.98	1.27	1.52
Cellophane 300 MSAT 86	Beginning to Soften	0.10	0.20	0.43	0.63	0.79
Aluminum Foil .00035	Beginning to Soften	0.10	0.25	0.43	0.55	0.66
Lumarith 100 ga P-912	Beginning to Soften	0.85	1.73	2.49	3.30	3.95
Pliofilm 100 ga (Stretch-wrapped)	Beginning to Soften	0.30	0.65	0.91	1.17	1.33
Pliofilm 75 FF	Beginning to Soften	0.23	0.58	0.79	1.06	1.24

[1]Room Temperature 75-85° F.

able to investigate the possibilities of the use of an activated carbon filter in the storage of this fruit. For this purpose, an activated carbon unit was installed in one of the storage boxes. This filter unit consists of two perforated double walled canisters, the space between the double walls of which is filled with the activated carbon, and is equipped with a blower fan. This blower fan circulates the gases of the storage box through the filter allowing for their absorption by the carbon.

TABLE 3. EFFECT OF VARIOUS WRAPPING MATERIALS AND TEMPERATURE ON LOSS OF WEIGHT OF HADEN MANGOS [1]—1948

Wrapping Material	Storage Temperature	Percent Loss in Weight after Days 3	6	9
No wrapper	R.T. [1]	4.00	8.00	12.07
	45°F	1.47	2.60	3.68
Vinylite 20 ga P9V (chem. treated)	R.T.	0.98	2.19	3.44
	45°F	0.29	0.49	0.69
Sylphwrap 330 ga PMB 6 C8X	R.T.	0.82	1.94	3.04
	45°F	0.11	0.24	0.40
Cellophane 300 ga MSAT 86	R.T.	0.36	1.10	1.88
	45°F	0.02	0.11	0.17
Aluminum Foil .00035	R.T.	0.53	1.24	1.61
	45°F	0.07	0.16	0.22
Lumarith 100 ga P-912	R.T.	3.30	7.00	10.62
	45°F	0.95	1.77	2.56
Pliofilm 100 ga (Stretch-wrapped)	R.T.	1.04	2.08	3.07
	45°F	0.13	0.24	0.38
Pliofilm 75 FF	R.T.	1.02	2.19	3.86
	45°F	0.30	0.46	0.64
Vinylite 100 ga P9V	R.T.	1.88	4.07	6.15
	45°F	0.43	0.76	1.07

[1] R.T.—Room Temperature—(75-85°F)

Sixty firm ripe Haden mangos were divided into six groups of ten fruit each and treated as indicated in Table 4. The Good-rite VL-600 referred to in this table is an experimental plastic dip manufactured by B. F. Goodrich Chemical Co., of Cleveland, Ohio. This mixture was prepared by diluting one volume of the concentrated material with four volumes of water containing a small amount of Triton X-30 as a wetting agent.

A comparison of the data in this table shows that both the Pliofilm wrap and Good-rite dip were effective in reducing the moisture loss from the fruit. All of the samples stored in the box containing the activated carbon filter showed considerably less rot than did those stored in the box without a filter. Pitting was also less severe in the treated fruit stored in the box containing the carbon filter.

Some mangos in addition to those reported in this experiment were also stored in the box without the filter which may have affected these results to some extent. If, however, the larger volume of fruit stored in the box without the filter increased the rot and pitting of the thirty fruit in question, it should substantiate the supposition that some of the breakdown of this fruit may be caused by the accumulation of gases given off by the fruits themselves.

These results indicate the advisability of more extensive research on the purification of the air in mango storage rooms.

Avocados

During the 1948 season, an experiment was undertaken to determine the effect of various wrapping materials on the storage life of avocados. The avocados used in this experiment were mature, firm fruits of the Trapp and Waldin varieties. Twenty fruit of each variety were wrapped in the six materials listed in Table 5, and twenty left unwrapped as checks. Ten fruit of each group were stored at room temperatures and ten stored at 45°F.

TABLE 4. EFFECT OF ACTIVATED CARBON FILTER, PLIOFILM, AND PLASTIC DIP ON THE KEEPING QUALITY OF HADEN MANGOS STORED AT 45° F 1949

Fruit Treatment	Percent Loss in Weight After Days 6	13	20	28	35	Period of Ripening Days	Percent Showing Rot After 35 Days	Pitting After 35 Days
No Filter								
Check	1.81	4.82	6.26	8.48	11.55	13	100	Severe
Pliofilm 20 ga	0.27	0.76	1.59	1.50	2.50	25	60	Severe
Goodrite VL-600 Latex 1:4 [1]	0.47	1.57	2.51	3.54	4.85	25	30	Severe
Activated Carbon Filter								
Check	2.10	4.77	7.02	9.24	11.50	13	20	Severe
Pliofilm 20 ga	0.70	1.09	1.12	1.56	1.80	25	0	Medium
Goodrite VL-600 Latex 1:4 [1]	0.81	2.09	2.96	4.06	5.10	25	0	Slight

[1] Experimental Product of B. F. Goodrich Chemical Company.

TABLE 5. EFFECT OF VARIOUS WRAPPERS AND TEMPERATURES ON LOSS OF WEIGHT OF TRAPP AND WALDIN AVOCADOS—1948

Variety	Wrapping Material	Storage Temperature	Percent Loss in Weight after Days									Percent Marketable Fruit After Days							
			4	6	8	11	13	14	17	18	20	27	4	6	8	11	13	18	19	27
Trapp	Pliofilm	R.T. [1]	1.12	1.49	.....	2.97	3.74	.....	.....	4.74	.....	.....	40	40	.....	.....	10	0	.....	.....
	NF 75	45°F	.....	0.37	.....	.....	.....	(0.75	.....	.....	1.12	1.50	100	90	.....	.....	60	(....	30	10
		45°F-R.T. [2]	.....	.....	.....	.....	.....	(.....	.....	.....	2.57	.....	.....	.....	.....	.....	.....	(....	10	0
Trapp	Vinylite	R.T.	.....	2.18	3.40	6.05	.....	.....	.....	.....	.....	.....	100	90	50	0	.....	.....	.....	.....
	20 ga P9V	45°F	.....	0.56	.....	.....	.....	(1.04	.....	.....	1.54	2.14	100	100	.....	.....	100	(....	40	20
	(Chem. Treated)	45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	3.00	.....	.....	.....	.....	.....	.....	(30	30	.....
Trapp	Sylphwrap	R.T.	1.36	2.04	.....	5.16	.....	.....	.....	.....	.....	.....	90	30	20	0	.....	.....	.....	.....
	PMB 6 CSX	45°F	.....	0.37	.....	.....	.....	(0.96	.....	.....	1.50	2.08	100	100	.....	.....	100	(....	50	40
	330 ga	45°F-R.T.	.....	.....	.....	.....	.....	.....	.....	.....	2.59	.....	.....	.....	.....	.....	.....	(40	10	0
Trapp	Cellophane	R.T.	0.61	1.06	.....	.....	.....	.....	.....	.....	.....	.....	50	0	.....	.....	.....	.....	.....	.....
	300 ga	45°F	.....	0.21	.....	.....	.....	(0.53	.....	.....	0.72	1.10	100	90	.....	.....	90	(....	50	40
	MSAT 86	45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	1.84	.....	.....	.....	.....	.....	.....	(40	0	.....
Trapp	Lumarith (Cellulose Acetate) 100 P-912	R.T.	.....	8.02	10.95	16.11	.....	.....	.....	.....	.....	.....	100	90	80	10	.....	.....	.....	.....
		45°F	.....	3.17	.....	.....	.....	(6.65	.....	.....	.....	.....	100	90	.....	.....	0	(....	.....	.....
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(....	.....	.....
Trapp	Aluminum Foil	R.T.	.....	0.97	1.99	3.56	3.62	.....	.....	6.50	8.15	.....	100	90	80	.....	20	.....	.....	.....
	.00035 ga	45°F	.....	0.28	.....	.....	.....	(0.76	.....	.....	1.30	.....	100	100	.....	.....	100	(....	50	0
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	3.63	.....	.....	.....	.....	.....	.....	.....	.....	(50	.....	0
Trapp	Check	R.T.	.....	11.45	15.38	21.46	.....	.....	.....	.....	.....	.....	100	90	80	0	.....	.....	.....	.....
		45°F	.....	4.15	.....	.....	.....	(6.80	.....	.....	12.00	.....	100	100	.....	.....	100	(....	50	0
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	15.83	.....	.....	.....	.....	.....	.....	.....	.....	(50	.....	0
Waldin	Pliofilm	R.T.	.....	1.24	1.89	2.39	2.62	.....	.....	.....	.....	.....	100	80	60	10	0	(....	.....	.....
	NF 75	45°F	.....	0.28	.....	.....	.....	(0.61	.....	.....	0.94	1.24	100	100	.....	.....	100	(....	50	40
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	2.16	.....	.....	.....	.....	.....	.....	(40	0	.....
Waldin	Vinylite	R.T.	.....	1.96	3.21	3.72	4.44	.....	.....	.....	.....	.....	100	90	70	20	0	.....	.....	.....
	20 ga P9V	45°F	.....	0.45	.....	.....	.....	(1.01	.....	.....	1.44	2.02	100	100	.....	.....	100	(....	50	20
	(Chem. Treated)	45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	3.45	.....	.....	.....	.....	.....	.....	(40	30	0
Waldin	Sylphwrap	R.T.	.....	1.60	.....	3.61	3.83	.....	.....	.....	.....	.....	100	80	.....	10	0	.....	.....	.....
	PMB 6 CSX	45°F	.....	0.47	.....	.....	.....	(1.15	.....	.....	1.55	2.07	100	100	.....	.....	100	(....	50	30
	330 ga	45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	3.44	.....	.....	.....	.....	.....	.....	(30	10	0
Waldin	Cellophane	R.T.	.....	0.84	.....	2.20	.....	.....	.....	.....	.....	.....	90	60	50	0	.....	.....	.....	.....
	300 ga	45°	.....	0.18	.....	.....	.....	(0.48	.....	.....	0.91	1.41	100	100	.....	.....	100	(....	50	.....
	MSAT 86	45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	2.05	.....	.....	.....	.....	.....	.....	(....	40	10
Waldin	Lumarith (Cellulose Acetate) 100 P-912	R.T.	.....	6.89	9.28	14.56	.....	.....	.....	.....	.....	.....	100	90	40	30	0	.....	.....	.....
		45°F	.....	2.28	.....	.....	.....	(4.85	8.96	.....	6.89	.....	100	100	.....	100	100	(....	0	.....
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(0	.....	.....
Waldin	Aluminum Foil	R.T.	.....	0.89	.....	3.68	2.92	.....	.....	4.57	.....	.....	100	100	.....	100	30	.....	.....	.....
	.00035 ga	45°F	.....	0.24	.....	.....	.....	(0.69	3.37	.....	1.40	.....	100	100	.....	.....	100	.....	.....	.....
		45°F-R.T.	.....	.....	.....	.....	.....	(.....	.....	.....	3.91	.....	.....	.....	.....	.....	.....	.....	.....	.....
Waldin	Check	R.T.	.....	10.72	14.48	19.44	.....	(.....	.....	.....	.....	.....	100	100	100	0	.....	.....	.....	.....
		45°F	.....	3.07	.....	.....	.....	(6.48	.....	.....	8.85	.....	100	100	.....	.....	100	.....	.....	.....
		45°F-R.T.	.....	.....	.....	.....	.....	.....	13.67	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] R.T.—Room Temperature—(75-90°)

[2] 45°F—R.T.—Fruit held 2 weeks at 45°F then removed to room temperature.

TABLE 6. EFFECT OF VARIOUS WRAPPING MATERIALS ON THE KEEPING QUALITY OF TRAPP AVOCADOS—1949

Type of Storage	Wrappers	Percent Loss in Weight after Days					Percent Ripe After Days			Percent & Severity of Pitting After 19 days			Percent Showing Browning of Skin
		4	6	10	13	16	19	21	16	19	21	Slight	Medium	Severe	after 19 days
No Filter 45°—R.T.[2]	No wrapper	1.12	1.67	2.60	3.37	4.57	9.34	12.31	0	70	100	0	0	100	20
	Pliofilm 20 ga	0.28	0.31	0.36	0.52	0.49	1.15	1.92	0	50	100	0	60	30	50
	Polythene 150 ga	0.25	0.32	0.28	0.40	0.52	1.00	1.48	0	50	60	40	10	30	90
	Aluminum Foil .00035	0.18	0.32	0.77	1.10	1.21	2.91	3.28	0	70	100	50	40	10	60
	Cellophane 300 ga LSAT	0.12	0.32	0.79	1.01	1.60	4.34	6.01	0	30	90	50	20	30	60
	Latex 1:2[1]	0.73	1.27	2.17	2.58	2.82	6.28	8.90	0	50	90	20	20	60	60
Carbon filter 45°—R.T.[2]	No wrapper	1.87	2.68	4.25	5.43	6.52	11.68	14.85	10	70	90	10	80	10	50
	Pliofilm 20 ga	0.24	0.28	0.29	0.41	0.53	1.22	1.39	0	10	60	30	50	0	70
	Polythene 150 ga	0.05	0.06	0.09	0.27	0.33	0.92	1.02	0	20	90	10	40	50	90
	Aluminum Foil .00035	0.36	0.42	0.84	1.33	1.71	3.68	5.27	0	50	100	40	50	0	70
	Cellophane 300 ga LSAT	0.52	0.73	1.25	1.69	2.04	4.57	6.42	0	20	70	10	40	40	20
	Latex 1:2[1]	0.97	1.48	2.32	2.95	3.51	6.08	8.00	10	50	80	10	60	10	50
Moss Filter 45°—R.T.[2]	No wrapper	1.11	1.63	2.72	3.50	4.18	9.86	12.69	0	70	100	0	100	0	40
	Pliofilm 20 ga	0.16	0.21	0.31	0.39	0.36	1.15	1.57	0	0	50	30	40	30	40
	Aluminum Foil .00035	0.11	0.25	0.74	1.15	1.18	3.19	3.24	0	50	80	20	50	20	50

[1] Experimental Product of B. F. Goodrich Chemical Company.
[2] 45°—R.T.—Fruit held 16 days at 45°F then removed to room temperature (75-90°).

for two weeks after which time half of those remaining in each of the latter groups were transferred to room temperature.

Table 5 summarizes the data obtained regarding the percentage of moisture loss and number of marketable fruit throughout the period of storage. Fruit were designated as not marketable when they became overripe or showed signs of pathological or physiological breakdown. Although this table shows the actual number of marketable fruit, it does not indicate the superiority in appearance of some of these marketable fruit as compared with one another. It was noted that the Trapp and Waldin avocados wrapped in aluminum foil and stored at either temperatures were superior in appearance to the majority of the other wrapped or unwrapped fruits, with the possible exception of the Trapp avocados wrapped in 300 gauge MSAT, Cellophane and stored at 45°F.

It is evident from the data presented in Table 5 that differences in wrapping materials and storage temperature materially effect the rate of moisture loss and period of marketability of both varieties of avocados. Pathological and physiological breakdown were observed to at least some extent in each group of fruit regardless of whether they were wrapped, unwrapped, stored at 45°F., or at room temperature.

In view of the amount of pathological and physiological breakdown which occurred in the avocados of the previous year's investigation, it was decided to focus more attention on possible means of controlling such breakdown.

Three identical storage boxes equipped with draft fans were set at 45°F, which is within the temperature ranges recommended by Lynch and Stahl[2] for the storage of Trapp avocados, the variety used in this investigation. The first storage box, which served as a control, contained no filter for the removal of storage gases; the second, contained the activated carbon filter described above; and the third, contained a Spanish moss filter. The Spanish moss filter is an adaptation of the "Krebser" method of fruit preservation[1]. This

technique, which originated a few years ago in Switzerland, consists of circulating the air of the storage room through layers of fresh, living, sphagmum moss. The workers in that country have found that the sphagnum moss helps maintain a constant relative humidity, retards the development of microorganisms on fruits, and absorbs the volatile substances evolved by the fruit such as ethylene and acetaldehyde.

"Field run" Trapp avocados were obtained from a local packer and carefully graded so as to obtain as near uniform samples as possible.

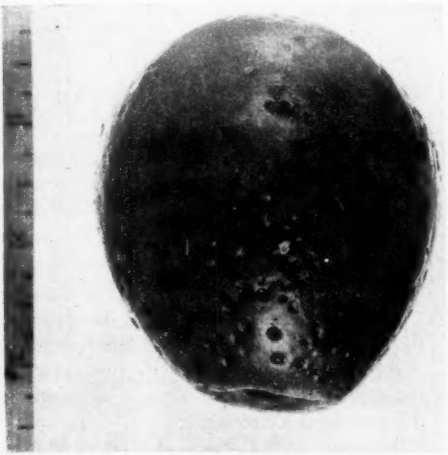

FIG. 1—Pitting of Trapp Avocado

Each sample consisting of ten fruit was treated as indicated in Table 6 and placed in the respective storage boxes for sixteen days after which they were transferred to a laboratory bench and allowed to ripen.

These data substantiate the findings of the previous year with regard to the ability of various wraps to decrease the rate of moisture loss from avocados. The greater moisture loss in the unwrapped fruits stored in the box containing the activated carbon filter can be attributed to the extra air circulation within this box due to the blower fan attached to the filter. A comparison of the data on moisture loss for the Trapp avocados stored in 1948 as compared to 1949 will show similar discrepancies. As the avocados were stored in different storage rooms equipped with different sized fans on the two consecutive years, this difference in moisture loss can also be attributed to difference in the rate of air circulation.

During the first sixteen days storage at 45°F, very few of the fruit ripened; however, most of the fruit ripened within three to five days after being transferred to room temperature. Apparently the activated carbon filter and the Spanish moss filter were both effective to some degree in absorbing the ethylene gas which is partially responsible for fruit ripening as almost all the wrapped fruit which had been stored in the boxes containing the filter ripened more slowly when transferred to room temperature than did those removed from the box which contained no filter.

A very high percentage of pathological and physiological breakdown occurred in all of the avocados. Pitting of the skin, which occurred in both the wrapped and unwrapped fruit, first appeared after ten days storage and gradually increased thereafter until the fruit ripened. Although no browning of the skin occurred after sixteen days storage at 45°F., it rapidly developed after the fruits were transferred to room temperature. Almost all of the ripe fruits showed browning of the flesh between the vascular bundles and the

FIG. 2—Internal Browning of Trapp Avocado.

seed. This type of breakdown is similar to that described by Lynch and Stahl[2] as "cold damage." Figures 1 and 2 show the typical appearance of the pitting and internal browning which occurred on these avocados. Neither the wraps, dips, nor filters seemed to have any appreciable effect on retarding any of this pathological or physiological breakdown.

SUMMARY

This report describes the preliminary work which has been completed to date on the storage of mangos and avocados at this institution. A comparison is made of the effect of various packaging and dipping materials, temperature, and filters for the removal of ethylene upon the storage life of these fruits. Although various means have been found to decrease the moisture loss and rate of ripening of mangos and avocados in storage, additional work is needed to determine means for the control of pathological and physiological breakdown which are prevalent during the storage of these fruits.

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INVESTIGATION OF THE PROPER MATURITY OF TAHITI LIMES FOR MARKETING

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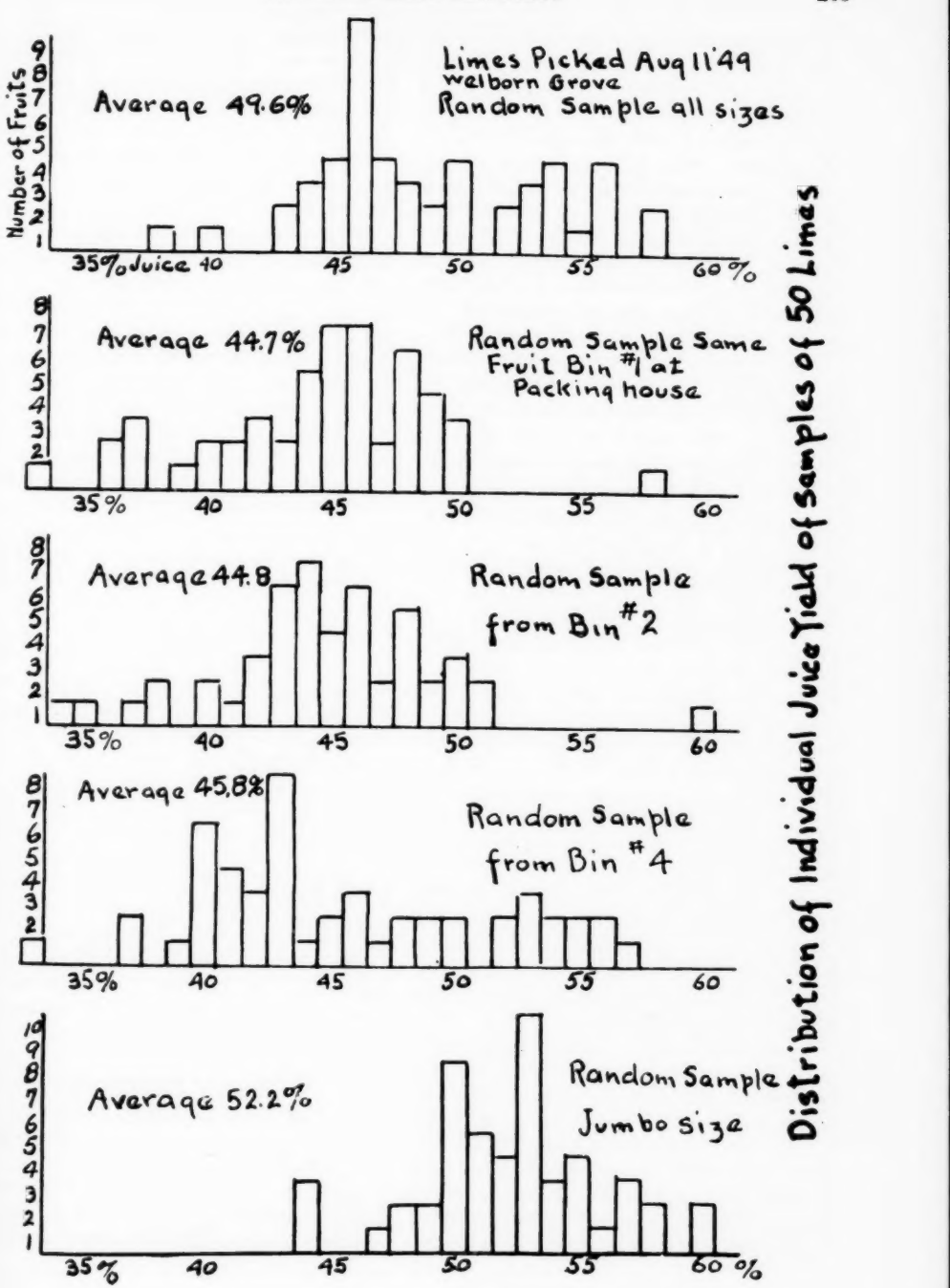
This paper is a report of preliminary work done on an assignment to study the behavior of Tahiti limes, which contained definite amounts of juice, such as 40, 45, 50, 55 percent of their volume. The Florida Lime Fruit Maturity Law has the single requirement that limes for marketing shall on the average yield 40 percent of their volume in juice. Officially this juice is obtained for inspection by the use of a Hamilton Beach Extractor No. 32. This is a hand pressure type of extractor in which a half of the fruit is forced onto a stationary perforated metal cone. In this investigation the juice was extracted with the above equipment and reported as percent of the volume of the fruit. It is not uncommon to find limes that will yield 60 percent of their volume in juice. The official inspection procedure is to make the juice determination on a sample of ten fruits, the volume of which is measured by the amount of water it displaces. The study being reported was started in August of 1949 which was toward the end of the lime production for that year. Even though the Tahiti lime is an everbearing tree the bulk of the crop is harvested during the middle of the summer.

This preliminary study was to determine the variability in samples of limes and what change in juice yield could be expected in fruit stored and similar fruit allowed to remain on the tree for a longer time.

A study on the effect of increased age of Tahiti limes on the yield of juice, acid, and soluble solids has been made by S. J. Lynch[1]. In the cases where the yield of juice was determined on the individual fruit of the sample, one is impressed with the wide variation within a sample of fruit of the same age. From this, one would not be encouraged to look in fruits of the same age for a working sample of fruits having individually the same definite juice content.

H. J. Reitz and J. W. Sites[2] have made a very detailed study of sampling Valencia oranges from one tree. In their study the values for the internal quality for 1800 individual fruits from a single tree are related to their positions on the tree. These authors make this statement: "Definite trends were noted in the case of soluble solids, ratio, and


Distribution of Individual Juice Yield of Samples of 50 Limes
Number of Fruits
Limes Picked Aug 11 '49
Welborn Grove
Random Sample all sizes
Average 49.6%
35% Juice 40 45 50 55 60 %
Average 44.7%
Random Sample Same Fruit Bin #1 at Packing House
35% 40 45 50 55 60
Average 44.8
Random Sample from Bin #2
35% 40 45 50 55 60
Average 45.8%
Random Sample from Bin #4
35% 40 45 50 55 60
Average 52.2%
Random Sample Jumbo Size
35% 40 45 50 55 60 %

vitamin C particularly, and slight trends for titratable acidity, while there appeared to be no definite relationship between the amount of juice in the fruit and the position of that fruit on the tree." In the same paper these authors state: "The range in juice content of the fruit was smaller than the range of any of the other juice constituents. The high value of 65.8 percent was only 2.0 times that of the low value." With the juice content of oranges of the same age on the same tree at the same time varying 100 percent there was no relation of the juice yield of the fruit to its position on the tree. In the present investigation on the maturity of Tahiti limes it is most important to find a means by which to select fruits with definite amounts of juice.

To obtain more definite knowledge of the variation in the juice content of limes the juice was measured from individual fruits of samples of fifty fruits and the data is shown in Fig. 1, as frequency of distribution of percent of juice. The fruits were from trees with grapefruit root stocks. These trees had been picked two weeks before. The graphs show the distribution of percent of juice from random fruit from a single tree and fruits of various sizes as obtained from the several bins of the packing house sizing machine. Fifty fruits were taken from the first bin which contained the smallest size, from bin No. 2 containing the next larger size, from bin No. 4 the middle size, and from the last bin holding fruit of the jumbo size.

The average juice yield for the 50 random samples of tree run fruit was 40.6 percent as shown in Figure 1 with only one fruit falling below 40%. The average for the sample from bin No. 1 was 44.7% with seven fruits yielding less than 40% of their volume in juice. The 50 individuals from bin No. 2 averaged 44.8% or the same as those from bin No. 1, but had fewer fruits yielding less than 40% of juice. The fourth bin sample had an average of 45.8% juice with four fruits falling below 40%. The fifty jumbo fruits averaged 52.2% juice with no fruits falling below 44%. Each of the five samples shown here had a spread of greater than 15 between their low and the high percent of juice. In no case was there a very good normal distribution of the individuals. If one were to assume that a fifty-fruit sample was more representative than a ten-fruit sample, one can speculate on how nearly ten random fruits of any one of these samples would give an average similar to that of the larger sample of 50.

From an observation of the distribution of the percent of juice of these 250 individuals one can see the impossibility of choosing groups of limes for study that will have a definite juice content when the selection is made on the basis of size. Or if one should be satisfied with lots that averaged the desired amounts it is easy to see how diversified the lots might be with a marked overlapping of the lots with supposedly definite amounts of available juice. After making many, many individual fruit determinations on lots of 50 fruits, in the fall of the year it was found that one will get the width of distribution featured in Fig. 1 with the average value frequently quite different from the mode.

These distribution diagrams show the number of fruits in samples of 50 which have various yields of juice relative to sizes. The difference in the average yield of juice as related to fruit size is not so great in this set of samples as has been found in some others. It is very important to know how these sizes are represented in any picking of fruit. For a large amount of low juice content fruit in bin No. 1 is not serious if only one or two percent of the fruit of a picking falls into this bin. It could be discarded without much loss. This investigation is much handicapped in that neither the packing house nor the grower knows how the fruit for a particular picking sized out. No figures are obtainable on the amount of the various sizes of the fruits produced or packed. If obtainable for a season one would know roughly the degree of maturity of fruit being handled at different seasons for there is generally a relation of size to degree of fruit maturity.

Lynch in a study of the seasonal changes in limes received by packing houses in 1938 by random samples of 20 fruits chosen at each of

four packing houses every two weeks showed that the average size of the fruits received increased as the season progressed. The largest fruit being received that year was in November and December. Yet the portion of the total crop picked in these months is almost negligible.

An opportunity to get some information on chance variation in percent of juice associated with the sampling of limes was afforded by lots of random fruits of definite sizes collected at the packing house by Dr. Robert A. Conover. The data is presented in Table 1. The designating figures in the first column simply mean four lots of limes of the same packing house size collected at the same time. Out of each lot a sample of 10 limes was taken August 12, and again on August 22 for determination of juice yield. The 6-4L and 6-4H are fruit of the same size but were selected by external appearance to have a low and a high juice content. The second column shows the spread between the lowest and highest of four juice determinations made by Dr. Conover on August 12. The several lots of limes were given to the author and on August 22 the yield of juice was determined on other samples of 10 limes from the same lots. The spread between the lowest and highest yielding samples for that date are given in the third column. The table shows the chance variation in the average juice yield of 10 limes within quadruplicate samples of fruit of the same packing house on two dates. The highest figures in the August 22 determinations were usually not from the same lot of the four lots as gave the higher yields on August 12. These figures give some idea of the confidence one can place in the average lots of fruit from the same trees and held under the same conditions. It would appear from this to be an insuperable task to select lots of fruits with very definite juice contents such as 40–45–50–and 55% of juice.

TABLE 1
SPREAD OF JUICE YIELDS WITHIN SETS OF FOUR SIMILAR SAMPLES

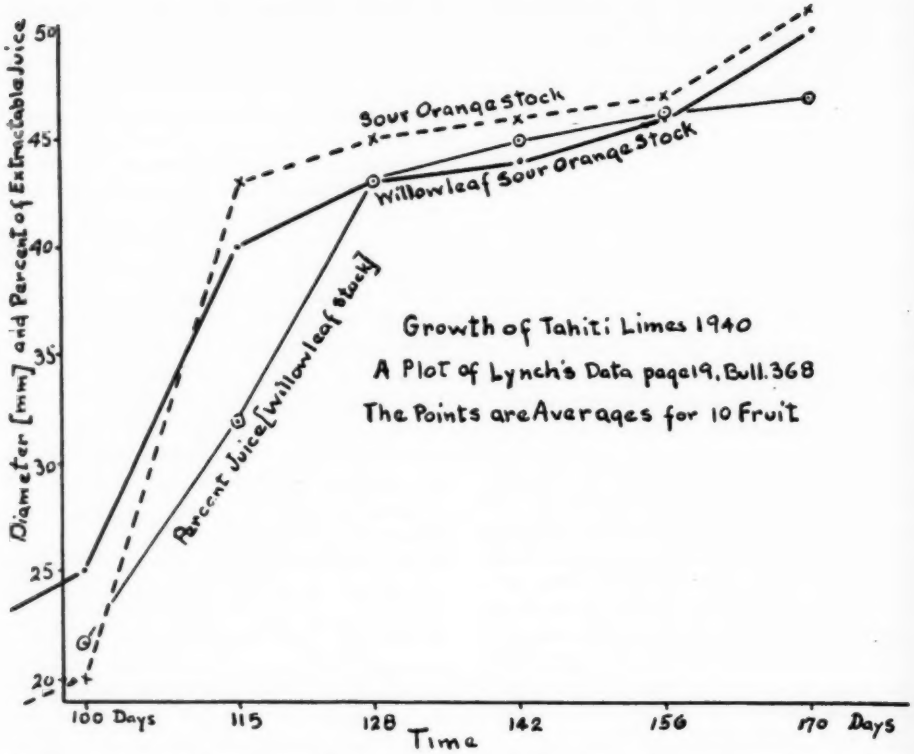
Sets of 4 Samples Each	August 12, 1949 Spread in percent juice Average for Sample	August 22, 1949 Spread in percent juice Average for Sample
1-4	52.2—53.5	55.2—59.3
2-4	47.4—48.8	50.3—54.3
3-4	51.2—54.5	55.0—58.9
4-4	43.9—48.6	49.6—51.5
5-4	43.0—46.8	45.5—48.0
6-4 L	40.7—44.3	40.2—47.1
6-4 H	47.4—50.8	49.7—52.6

The next point of consideration is what increase if any in the extractable juice occurs in a lot of fruit when allowed to remain longer on the trees? Some of the same fruit featured in Figure 1 was allowed to remain on a single tree for another 13 days. A random sample of 50 from the picked fruits had the juice determined individually and gave an average of 50.7%, only a slight increase over the 49.6% for the fruit picked 13 days earlier. But there was an appreciable increase in the average volume of the fruit from 70.9 ml to 86.5 ml in the 13 days.

The same experiment was done with fruits of the common Tahiti lime and the Ide-More selection, both grown on rough lemon stocks. The results were quite similar to those above, with the exception of the common lime lot of the second picking which showed a decrease in the average yield of juice. This decrease was due to the inclusion in this picking of a good many small limes which at the previous picking were undersize for harvesting.

At this point it is desirable to present a graph made from some of Lynch's data on the change in size of fruit and extractable juice with increase in age of the fruit from 100 to 170 days, when sampled at two week intervals. His fruit was obtained from trees to show the effect of six different stocks. Fig. 2 shows graphs for the increase of fruit diameter with age on two different stocks—sour orange and willowleaf sour orange, which is a mandarin. The decrease in percent of extractable juice from fruits of the trees on willow leaf stock is also placed in the graph to show how closely it follows the increase in size of the fruit. Each sample consisted of 10 tagged fruits. The age of this fruit was known by tagging it as soon as it was set.

These graphs show an abrupt change in the growth of fruit and percent of extractable juice at an age of 115 to 128 days. This may distinguish a definite point in the growth and development of the fruit which should be further investigated. The fruit juice sacks should be observed at about this age for



changes in size and liquid condition of their contents. The development of the oil vesicles and the smoothing of the rind should also be observed. By the 128th day the percent of extractable juice had reached 43% as the average for 10 fruits but the individual fruits themselves yielded from 37.8% to 50%. It was not until the 170th day that all of the fruit yielded over 40% by weight. In the fruits on two stocks other than those shown in the graph, even on the 170th day there were individuals with only 37% juice. Although the average for these samples was above 45%, there may be some very poor and some very good fruit in a sample of the same age.

The fruits represented in this graph could not be said to have reached their maturity until after the 170th day for their size had been steadily increasing and so had their available juice. In fact the fruits on the two stocks had had a spurt of growth in the previous two weeks. Lynch does not state what the general condition of the fruit was on the 170th day or what changes might have taken place after this time. Usually fruits of the size indicated would be considered a little above medium size. The fact, that there is such a wide range in size and percent of extractable juice in fruits of identical age is very disconcerting when attempting to plan an experiment which requires every fruit to have a definite juice content.

What change in the yield of juice occurs after the fruit is picked was given consideration by storing fruit in the laboratory for various lengths of time. The laboratory temperature ranged from 83 to 88°F. with an average relative humidity of 70%. Some of the fruit featured in Fig. 1 was held in a half filled field box for 5, 7, and 16 days. The

average of 50 fruit samples which at the beginning was 49.6% showed no change by the 5th and 7th day. In 16 days the average juice yield of 50 individual determinations had increased to 55% calculated on the present fruit volume which had decreased on the average from the original of 70.9 ml to 50.9 ml. Therefore a considerable shrinkage had occurred during the storage period. While the fruit does mellow during storage the increase in yield of juice is mostly a result of shrinkage of the volume on which the calculation is made. An investigation of this point was made and it was found that at the beginning of the storage period the loss in volume was much more rapid than loss in weight, which likely means that the water is first lost from the rind where considerable shrinkage is possible particularly with the fruits having a thicker rind. The greatest shrinkage in the rind is at the region over the junctions of the internal segments giving a ribbed appearance to stored fruit. The data reported above was from fruits with a rather thin rind associated with the grapefruit understock used. The relative change in volume to weight in limes means that the specific gravity of the fruits change which is actually the case for the fruits at picking time floated in water and would not float after several days of storage.

Several experiments were made to determine the shrinkage of fruit on standing in the laboratory where the temperature was 83-88° F. with an average relative humidity of 70%. One will be reported in which the comparison of waxed and unwaxed fruit was made. The wax was "Flavor-Seal" applied in the packing house. The fruit tested consisted of random samples of 17 each of unsized fruit. The fruit was selected August 19 and had been grown on grapefruit understock, and was held in the laboratory for nine days. There were two samples of waxed fruit and one of unwaxed. During the storage period of nine days the first waxed sample lost 6.7% in weight, 8.5% in volume and gained 5.5% in yield of juice by volume. The second waxed sample in the same time lost 8.3% of its weight and 12.1% of its volume with an increase of 6.0% in yield of juice. These latter amounts are all greater than the first. The unwaxed sample lost 12.0% of its weight and 14.5% of its volume with a gain of 8.0% in yield of juice. In all cases there there was a greater loss in volume than of weight. The unwaxed fruit lost more weight and volume than did the waxed fruit, and consequently gained more in yield of juice. It is surprising that the application of the wax did not afford a more complete protection from shrinkage. The natural oil of the lime is confined to glands and would be unable to prevent water loss. A waxy cuticle would however. At this time no knowledge can be found of a natural wax occurring on the outer surface of limes.

The relation of the percent of extractable juice to the total moisture of the sample was investigated using fruits of varying sizes from the same lot of fruit. This has been repeated three different times with the summarized data presented in Table II. It will be noted that the sizes are not exactly the same in three trials. This means that the several sizes had to be taken by hand from the various pickings used and there were not fruits of exactly the same size available. The results obtained show that the smallest size has the least total moisture and the largest size may have the most. No juice was obtainable from the smallest size with the equipment used. It will be seen that usable limes have a total moisture content of around 85%, and with a juice yield of around 50%, and about 60% of the total moisture of the fruit is obtained in the laboratory juicing process. The lower the yield of juice in these fruits, the smaller the percentage of the total moisture is obtained in the process. In these three collections will be found some fruit of approximately the same size, the largest size in the first two and next to the largest in the third. Their respective yields of juice is shown to be 55.8, 52.2, and 42.2 percent. In this case there is no relation of yield of juice to size of fruit, but there is within each of the three collections. It is appreciated that in making the calculation for percent of total moisture extractable as juice that figures are used which are obtained by both weight and

TABLE 2
SIZE OF FRUITS, TOTAL MOISTURE AND EXTRACTABLE JUICE

	Fruit Diam. mm.	% Water by weight	% Extractable juice by volume	% Water Extractable as juice
K-K Grove	59	86.0	55.8	64.8
Aug. 17, 1949	53	84.9	51.0	60.0
10 fruits of	46	84.0	42.0	50.0
Each size	40	84.3	40.4	47.9
	28	80.4	0	0
Riboud Grove	58	86.4	52.2	60.4
Aug. 25, 1949	53	85.4	51.4	60.1
10 fruits of	46	84.0	42.0	50.0
Each size	36	80.3	0	0
Riboud Grove	61	85.0	43.4	51.0
Oct. 8, 1949	58	85.7	42.2	49.1
10 fruits of	54.5	85.3	42.0	49.2
Each size	50	85.4	40.3	47.1
	38	83.0	0	0

volume, but the difference in the results obtained after correcting the figures is too small to add to their relative value. The explanation for the low yield of juice from the fruit of the third series is not to be found. The explanation possible is that it was picked after a rainy period, which in the opinion of some lime growers reduces the juice content of the fruit. There are cases known of good sized fruit remaining dry with no satisfactory explanation.

In Lynch's study titratable acid was determined in most cases. He found it to be 5 or 6 percent and that it did not change with the age of the fruit. His samples collected at the packing houses showed no change during the season. There was no change in acid in fruit samples stored for 13 days so the amount of titratable acid may be considered as a constant in juice from limes.

Summary

In this preliminary study is has been found that there is a great variation in the yield of juice from individual limes of the same age or of the same size. Average values are not very representative of a random sample of limes. There has been no external character of the lime found by which the approximate yield of juice can be ascertained. The percent of juice obtainable increases as the fruit increases in size. The increase in the available juice from stored fruit is largely accountable to shrinkage of the rind.

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WATER DAMAGE TO TROPICAL PLANTS

D. J. McSwiney

Fort Lauderdale

The severe losses to citrus growers resulting from the flood which accompanied the storm of October 1947 have overshadowed the fact that other species of plants than citrus also suffered from the flood. The hundreds of introduced species showed marked variation in flood resistance; many were killed outright, while others showed a resistance which, in some cases was surprising, considering their origin and ancestral history.

There is little in the literature covering flood resistance of plants, although such information should be of horticultural value, and of some interest from a standpoint of plant physiology. Following the flood, I made a record of it's effect on the plants on my property—comprising some 420 species of about 280 genera. I would suggest that others who experienced flood damage submit a similar list for record to add to the number of species observed, as well as to the number of individuals of each species; in the present case, with many species, only one plant was available for observation, but the effect of flooding is probably determined to some extent by variations in individual vitality, in degree of exposure to sunlight, and in differences in the chemical, physical, and biological characteristics of the soil.

The flood covered my land for a period of from about ten days on the highest spots to about fifty days on my lowest land. In addition, for weeks previous to the October storm, we had almost daily heavy rains which kept the ground saturated, and the lowest land, frequently, flooded. Moreover, the run-off was so slow that the top six to eight inches of soil did not drain until one to three weeks after the surface water had cleared. As far

as could be determined, the flood water was at all times fresh.

Within the narrow range of species observed, there was a suggestion that the degree of resistance to flooding might, in some cases, be a generic or even a family characteristic. Thus, the different species here of Ixora, of Eugenia and closely related genera, of the Combretaceae and of the Malpighiaceae all showed good resistance, while those of the Araliaceae and Ancanthaceae showed only a moderate and those of the Cycadaceae a poor resistance.

To me, the most interesting observation was the large number of plants ordinarily considered to be drought resistant which proved to be flood resistant as well. Such are *Parkinsonia aculeata, Lawsonia inermis, Oncoba spinosa, Nerium oleander, Plumeria emarginata, Carissa grandiflora, Punica granatum* and many others.

With many plants, destruction by flooding, while often rapid, once it had started, appeared to be a progressive process, with the parts above-ground usually being killed more rapidly than those underground. Some woody plants showed only the outer portions of some branches killed, others entire branches or part of the main stem, while others, again, were wholly killed above-ground but gradually recovered, at least in part, by sprouting up again from the roots. A medium sized—25 to 30 ft. high—*Bischofia javanica* was apparently killed completely by the flood, but after a considerable period it sent out sprouts from the trunk a foot or two above the ground, and, now, two years after the flood is making steady continuous growth. Clumps of *Jacobinia coccinea* and of *Holmskioldia sanguinea* completely killed above ground eventually sprouted again from the roots. Among herbaceous plants, a large number of clumps of *Zingiberaceae* were killed completely above ground by moderate to severe flooding; of the number which survived underground a gradual destruction of roots and stolons showed by the clumps sprouting being smaller than the original in an order roughly that of the severity of flooding.

Some herbaceous plants which did not survive moderate flooding, such as peperomias and commelinas are those which are often rooted in water and grown as house plants in water for extended periods of time. Apparently in such cases, flooding, per se, is not the sole cause of their killing.

Among the tropical fruits, mangos seem to be outstanding in flood resistance. Others which showed good resistance are the *Flacourtias, Carissa grandiflora, Malpighia punicifolia, Muntingia calabura,* Guavas, *Diospyros ebenaster, Jambolan* and various *Eugenias.* Among those showing unsatisfactory resistance are Avocados, Loquat, Akee, Ceylon gooseberry and Carambola.

Of common ornamental plants, the following showed low resistance, (killed by approximately three weeks flooding or less) Hibiscus, Poinsettias, Aralias, Acalyphas, Flame vine (*Pyrostegia*), *Pandorea* (*Podranea*), Cestrum nocturnum, *Stenolobium stans, Tecomaria capensis, Thunbergia erecta, Clerodendrum fallax, Porana paniculata, Pentas* and Peperomias.

Crotons showed much greater resistance than most hibiscus, but some killed in severe flood. Those planted in marl appeared to show more resistance than the same varieties in sand or muck.

Single red hibiscus and versicolor showed poor resistance as well as hybrids grafted on the usual single red stock; peachblow showed much better resistance while *H. schizopetalus* and a few hybrids on their own roots showed good resistance. Where hibiscus is to be planted on land liable to flooding, consideration of the use of these more resistant stocks is suggested.

Common plants which showed good flood resistance (survived three weeks or more) are as follows: Ixoras, *Callistemon lanceolatus, Jasminum sambac, J. pubescens* and *J. azoricum, Murraea exotica, Nerium oleander, Thevetia nerifolia, Punica granatum, Plumeria emarginata, Malpighias, Vitex,* most although not all palms, *Lagerstroemia indica,* Bougainvilleas, *Schinus terebinthifolius, Allaman-*

da cathartica, Cryptostegia grandiflora, Quisqualis.

Trees suggested as both flood and wind resistant: *Pongamia pinnata, Calophyllum antillanum, Syzygium cuminii, Eugenia jambos, Kigelia pinnata, Tabebuia pallida, Ficus gnaphalocarpa, Diospyros ebenaster.*

It is, of course, to be understand that the term "good resistance" does not imply one indefinitely prolonged; few, if any, of these plants can be considered as hydrophytes, so that there is probably a limit to the extent of flooding any of them can stand.

OBSERVATIONS ON THE PROPAGATION OF PALMS

A. C. JORDAHN

Coconut Grove

Palms are very important in landscape work all over Florida where they add greatly in imparting the tropical atmosphere which distinguishes our state from the rest of the nation. Making available, to new home developers as well as old residents, abundant specimens of the rarer and more beautiful palms already here, and the introduction and propagation of the hundreds of untried species from foreign countries should be both a profitable and interesting undertaking for progressive nurserymen or palm specialists. Also, the growing of several species suitable for conservatories, living rooms and greenhouses in the north has become of considerable importance and it is hoped that these notes will be of value to those at present engaged in growing palms for home or northern disposal and will stimulate new growers to enter the field.

This demand for palms for the northern trade is at present limited to a very few species. They must be tolerant of shade as well as the dry atmosphere of heated rooms. They should be of fairly rapid growth in order to be grown profitably and they must present a finished appearance as rather small plants. *Chrysalidocarpus lutescens* and *Phoenix roebelenii* are now being raised in quantity and it should be possible to find several suitable ones among the many we are fortunate in being able to grow well here out of doors. Some of the Chamaedoreas might be suitable, also *Heterospathe elata, Actinophleous Mc Arthuri* and *Adonidia Merrillii, Livistonia, Thrinax* and *Caryotas* in several species. These are being grown here in numbers and it would seem that some of our enterprising nurserymen in time could build up a profitable trade in them.

Palms are almost always propagated from seeds. To be sure some of the various clump species may be propagated from suckers or divisions. That usually is done in cases where one homeowner might wish to increase his plants for planting and not on a scale that would amount to much. One exception is *Rhaphis flabelliformis.* This plant spreads by means of underground stolons and if these are severed from the parent plant they will make nice specimens when planted separately, and they grow on in faster time than if they were started from a seed. Another exception is the commercial date palm, *Phoenix dactylifera,* which is produced from suckers. Seedlings of even good varieties can not be depended on to produce worthwhile fruiting plants. Suckers of good varieties of dates are highly prized in areas favorable to the growing of this delectable fruit which Florida unfortunately is not, as our climate is far too humid for its proper ripening.

Palm seeds should be planted as soon as possible after reaching maturity. Some retain their viability for a considerable time but others lose it in a very short time and practically all give better results if seeded fresh. Having handled seeds imported from many different countries in a large variety of species the results have varied. From some sources they were invariably received in better condition than from others and the time consumed

in transit was not always the main reason for failure thereof, although it naturally played a large part. Time in transit can now be greatly reduced by the use of air mail. Other reasons for better results must be ascribed to the selection of fresh seeds and more careful cleaning and packing.

Cleaning the seeds of all pulpy matter is fully as important as getting fresh seeds. This is in most instances easily done by rubbing them in a rough wire screen till the pulpy matter is removed; then wash them in water and let them dry. If the seeds are shipped or planted without having the pulp removed, mold is likely to affect them.

Some palm seed coverings possess a very irritating substance which causes a painful itching of the skin of the person cleaning them. This can be avoided by scrubbing them with a stiff wire brush and not getting ones hands wet. Examples of these are *Caryota urens*, *Arenga saccharifera* and the Maya palm, *Opsiandra Maya*. The specific name of the first mentioned i.e. *urens* iterally means "burning" and from personal experience one can say that the name is well chosen. After handling a considerable number of them with bare hands one experiences the most excruciating itch, which lasts the better part of a day. A lady in Coconut Grove recently was obliged to have medical treatment for it after having handled some seeds. Arenga fruits have the same property and the inhabitants used a concoction of the juice against the Dutch in their wars with such effect that the Dutch called it "hell water."

The seeds of most species are best planted in shallow pots or flats according to size and quantity. A flat about 16"X24" and 3" deep is very suitable as it is easily moved about. Smaller quantities may be planted in earthen pans or pots, preferably also shallow, as that facilitates transplanting. Large seeds may be planted in individual pots for best results and coconuts are usually planted in nursery rows in the open ground. Such species as Hyphaene and Borassus cannot be started in an ordinary pot as in germinating they send a sinker or hypocotle down a distance of about 30". If this meets with an obstruction it will fail to develop. For such seeds a box about 6" square and 30" deep will do very well for each seed and the seedling may be grown on until large enough to be planted permanently. The seeds may of course be planted in permanent locations where they must be watered as one would the planted palm.

Soil for potting should be light and porous. Use ordinary good potting soil with the addition of rather more sand than usual and also a quantity of peat moss which helps retain moisture. With a few kinds of seeds, particularly those of the Oil palm, sphagnum has given faster and better germination than a soil mixture. The seeds should be covered with from ½" to 1" of potting mixture, watered well, and placed on the propagating bench. They should at no time be allowed to dry out nor should they be kept in a state of saturation. Should a cold snap occur just at the time the seeds are germinating it would be well to give them some protection as that seems to be a period when they are susceptible to cold. The ideal place to grow palm seedlings is of course a greenhouse but a slat house, back porch or even in partial shade under a tree will do well even though it requires a little more attention.

The time required for germination varies greatly. Some species germinate in from four to six weeks and practically all at one time; others vary irregularly. They may come, a few at the time, for the better part of a year. Acrocomias for instance, may take several years and on the whole no seeds should be discarded until the embryos are found to be dead upon examination. Such species as Thrinax, Phoenix, Sabal, Washingtonias, Chamaedorea, Chrysalidocarpus, Actinopheleous, Ptychosperma, Adonidia, Martinezia and Caryota are the most prominent ones that germinate comparatively soon. Such as Butia, Latania, Attalea, Scheelea and Copernicia are slower and often irregular. Coconuts require from four to six months. Some of the very tropical species, as Dr. Fairchild's special favorite, *Pigafettia elata*, probably germinate even sooner than the first mentioned, as they have

sprouted enroute in air shipment. Seeds of this palm, like others from the islands in the eastern hemisphere, certainly retain their viability but a short while. The only successful way to import them is by air mail. Unfortunately it does not find conditions here to its liking and is not to be recommended for outdoor planting. Florida as we know, is not always tropical, and it is not so surprising that some palms fail but rather that as many of even the very tropical ones apparently find conditions to their liking, thrive well and help make our state more interesting and beautiful.

Practices of potting and repotting vary. Some growers prefer to pot the small seedlings individually in small pots as soon as the majority of the seeds have germinated. Certainly there is less disturbance of the root system at that time, and they are easier to get into a small pot. Others prefer to wait until the small plantlets have made a little growth. In the case of those sprouting irregularly those that have germinated may very well be taken out and planted while the other seeds are left and firmed down again. In either case use as small pots as will accommodate the small plants, using a light porous mixture. Repot as the small plants need it with a somewhat richer mixture. For planting in the open ground the palms should be of some size, preferably from a six to eight inch pot. Smaller than that they do not get much of a chance of surviving. There are few plants that respond more noticeably to ample feeding and watering, than do the palms. Frequent light application of fertilizer gives best results and should be kept up throughout a longer portion of the year than is customary with trees and shrubs.

Having grown all the commonly planted palms, as well as many of the rarer ones, it has been a source of much pleasure to see some of these latter ones become quite popular and in demand. As that early pioneer in horticulture in this part of the state, Dr. Charles Torrey Simpson says in one of his early books, "You can't have too many palms" let us hope that there will always be places like the Fairchild Tropical Garden, Col. Robert H. Montgomery estate and U. S. Plant Introduction Garden, where new things may be tried and established plants given a chance to develop into greater beauty from year to year.

SUB-TROPICAL FRUITS IN ST. PETERSBURG HOME GARDENS

Mrs. Frank Walmsley

St. Petersburg

There is a current myth that we have no wildflowers nor good fruits in Florida save the citrus and avocados and mangos. It is very natural that people who whiz by on the main highways can see very little in the way of flowers or vegetation. It is very natural that those who vacation here in winter and vacation north in summer never do truly belong to Florida. The citrus and avocados have been well established in the tourist minds and diet. The great groves are not possible to miss seeing and smelling in flower and fruit and are a real attraction to our "foreigners." Even though increasing numbers of people from all parts of the country are owning more and more homes here, it does not follow that they are really *living* here. The large majority have winter residence. Even those spending the year here retain their transplanted status and thinking. Few of them ever become acquainted with the homes and gardens of those who love the real Florida contributions. It is especially in the summer, too, when the greatest number of our fruits and other horticultural treasures offer us of their bounty, that so many flee from that other myth—the Florida Summer! These treasures can not be enjoyed nor maintained if the home owner has closed his house for the summer.

When I began writing down this list of the fruits growing in our gardens of this area, I

picked up the Morton's Fifty Tropical Fruits of Nassau and browsed through it and as in the past I again marvelled that the large proportion of the fruits listed therein are on my list as growing here. There are some which do grow here but due to soil or rootknot or some as yet little understood reason for failure, are not really successful.

Enthusiasm is highly contagious and we have found our fruit-minded group working in the Garden Club, in our summer informal get-togethers have really made them little fruit forums. In this way many treasures have been found and tasted and tried out and shared. In this varied treatment resulting from different soils and water tables much has been learned about their needs.

Even in this day of rapid transportation there is much isolation. Many cannot go about in other areas of the State and do not know what is growing. But our Garden Club speakers and various publications and word of mouth from visitors from other areas bring us information, and little by little this education has progressed so that in taking stock of the progress in the twenty-five years since we became Floridians I find it is amazing to see our wealth of fruits. True, in many gardens in this rapid turnover of real estate the new owners know nothing of these plants and tear out and put in whatever the nurseryman advises or has available in order to make a "new look." Many of our fruits have suffered sadly in this way.

Avocados are well represented in our gardens. It is a very touchy tree when planted on land that stands wet during heavy rains. There are many fine trees, in seedling and grafted trees in a wide range of varieties. There are a number of commercial groves of avocados in the Indian Rocks area, where the fertile soil and freedom from wet feet suit its needs.

Mangos are particularly well suited to our area; due to our water protection we are favored and are the northern limit of mango growing, there are a few trees in Clearwater and Tampa in favored spots. Ten years ago the Haden was the only mango the nurseries offered and the only one the public ever asked for. There are some old trees that came from Reasoner's Royal Palm Nursery many years ago, Langra benarsi, Paheri, and such Indian types. Most of the trees are unkept and needing attention. These past ten or fifteen years have been a magic era in hybrid mango production. All of the finer hybrids are represented here and one often hears the remark. "No, I do not want the Haden, I want one of the finer new hybrids." In our own garden we now have seven different hybrids bearing or soon to bear, and one poor seedling tree is now grafted to three others, so we expect to have a very long season of epicurean delight in mango eating and canning.

The Sapodilla is represented by several large trees which seem to need a fertile soil but no wet feet. One tree that is quite old being really stunted by wet ground, though it does bear a few not-too-good fruit.

White Sapote does excellently here. There are quite a number around. It makes a very handsome tree, too. One fine fruiting specimen of C. edulis was cut down by the foolish owner so he could grow grass, although the tree was not the cause of his lawn failure. We have a Dade Sapote growing from budwood sent to me by Mr. Lynch several years ago. I heeled in some unused pieces and one took root. I hope for fruit next year. The C. tetrameria is represented by a nice bearing tree in one garden.

Papayas are grown abundantly in both home and commercial gardens. The improvement in these in the past score of years is phenomenal, but there is still great room for improvement and stabilization.

Guavas in variety are one of our great standbys, many of us collecting choice types and in addition to the several fine local garden types, those developed at the Sub-Tropical Experiment Station at Homestead are much treasured. Also found are many of the red Cattley guava and the yellow P. *lucidum*—one of my favorites for eating uncooked. The Britoa acida is also grown and relished here. The fine-grained, red-meated new hybrid with smaller seeds and seed mass is most choice for canning as well as eating out of hand.

There are a number of the *Flacourtia ramontchii,* in both the spiny and the spineless. In our garden we have both types, root propagated from bearing bushes . They bear well and we have eaten them from the bush all summer. One gardener has attained extremely heavy bearing by close interplanting of a male between three female bushes. They are so beautiful as foliage with the green and red combining that they are doubly valuable, though they are not possible to keep in small hedge as the Surinam.

Of Surinams the town abounds in many phases, as hedge, specimen bush or small tree, and there are many of the superior black Surinam. No cherry pie surpasses this pie.

Eggfruit, *Lucuma nervosa,* thrives well here but seems most slow in maturing. There is one fine tree at least 50 years old. This is, in a good strain, as fine a small fruit as there is, to my taste.

Figs, owing to the rootknot, are quite a liability but we do have them. We are growing the Government introduction, *Ficus gnaphalocarpus.* We are wanting to get the edible fig growing on this as we are told that it is so being grown successfully near here.

Cecropia palmata is said to be an edible fruit, but though we grow it and have seen a number around we have yet to taste the fruit—even supposedly having both sexes. It is very tropical looking and we enjoy it for that.

Muntingia calaburia, both red and yellow, is growing and fruiting well here and no one can pass by without gathering a handful of the sweet little fruits. Birds likewise enjoy their share. An attractive tree as well, though we find the tree may suddenly die and come up again from the roots.

The Lingaro, *Eleagnus philippinensis,* is another dual-purpose plant of great charm, the translucent small fruits enjoyed during the spring; thrives well here.

The Jaboticaba, *Myrciaria cauliflora,* we have growing and hope ere too many years to see fruit; there are several young ones about the home gardens.

Monstera deliciosa is so dramatic an ornamental that it is everywhere and numerous fruits are enjoyed, but far more are not used because the tourist resident does not know its worth . . . lack of education!

The Barbados cherry, *Malpighia glabra* has been tried many times and few succeeded because of the rootknot and light sandy soil. However, we are now growing it in containers. We would like to find it budded on resistant stock.

The Grumichama cherry, *Eugenia dombeyi,* is growing and fruiting well here and we consider it a very attractive small fruit and ornamental.

The Annonas have been tried many times and a number of fruit devotees have got together various strains as well as species and there has been little sustained success. They grow grudgingly to maturity and slowly peter out. One Clearwater man has a large collection but they are not thriving. Various causes of failure are suggested in addition to the lack of altitude.

Averrhoa carambola, sweet and sour, are bearing thriftily and well.

Pineapples are in many gardens and we do enjoy our own; the added zest of going into the garden and pulling them is always an adventure.

Tamarind—is it a fruit? It has the valuable properties we find in fruits and we do grow them. One notable tree in Detroit Hotel grounds bears heavily every year but is so large a tree the fruits remain unused. In our garden our Tamarind never was happy and after freezing to the ground three times it died at age of twenty, having flowered every year but setting no fruit. Our soil we felt was not the deep fertile one needed. It does resent an occasional frost.

The Ceylon Goosebery, *Dovyalis hebecarpa,* does very well in the average garden, attaining good size. The two bushes we had were loaded repeatedly during the year with no other bush of the male anywhere around.

Our Jambolan plum tree was very lovely and bore heavily, though our fruit was not of the best quality. It withstood one bad hurricane unscathed but was broken off two years

later in a lesser storm. Many are growing about town from its seed.

Our Indian Jujube, *Zizyphus mauritiana,* is a very attractive tree with one crop after another of flowers soon followed by the crisp little fruits. It is an excellent bee tree and the fruits are good to nibble on. A larger, finer type would be most welcome.

Antidesma bunius fruits well here though my two large bushes have flowered but have not set fruit. *Antidesma platyphylla* has grown well and flowered, but no fruit.

Bananas have proved of much interest to many of us. It is always a distinct surprise to residents when they taste our home grown Lady Fingers or Cavendishes. It really spoils one for the commercial bananas. Even in the poorest light sandy soil these luscious fruits can be grown, with protection from the Northwest winds and ample humus and water. One home gardener has a back lot circle of three varieties with a great humus-trash heap inside the ring and she gets an average 300 pounds a year.

The Lychee, *Litchee chinensis,* thanks to the enterprise of Col. Wm. R. Grove, has really taken hold of the imagination of the home gardener. We find Lychee trees everywhere, now, whereas fifteen years ago there were two trees known in our area. We find them in the yards of people who know nothing about any other tropical fruits. Col. Grove has indelibly stamped the word Lychee in thousands of minds and put the trees in their gardens, which all points to the tremendous value of education in stimulating the minds as to the value of lesser known fruits.

It means so much to the family to have well-stocked shelves of home grown canned fruits from the standpoint of taste. Think what it means, today especially, to the pocketbook! Mangos, pears, guavas, mulberries await our opening and all through the year we enjoy these and other fruits in season that do not lend themselves to canning. We do need good hybridization work on all our small fruits. Man- and avocados and citrus are already being wonderfully improved and the guavas and other small fruits are getting some notice. Perhaps in the next score of years there will be the great improvement there that has taken place in the past score of years in papayas, mangos, citrus and avocados.

Who says we have no small fruits in Florida!

General Business Meeting of Society

Tampa, Florida, November 3, 1949

The report of the Treasurer, Dr. Ralph L. Miller, was read and accepted.

Mr. R. S. Edsall reported the recommendations of the Executive Committee as follows:

(1) The number of Assistant Secretaries be increased from three to four, with the fourth Assistant Secretary being in charge of the editorial work in publishing the Proceedings.

(2) The office of the Secretary-Treasurer be divided into two separate offices in order to handle more efficiently the necessary duties of each.

(3) The Executive Committee be expanded from five to seven so that the various sections of the State could be covered.

The above recommendations were then adopted.

Mr. Frank Alexander gave the report of the Nominating Committee. The nominees as shown at the front of this Proceedings were unanimously elected.

The resolutions as passed are listed elsewhere in this Proceedings.

The meeting was adjourned.

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RESOLUTIONS

WHEREAS, it has come to the attention of the members of the Florida State Horticultural Society that the Secretary of the Treasury of the United States is giving thought to a change in the manner of inspection by Customs, of baggage brought in by passengers from abroad which would permit entry without inspection of many thousands of pieces of baggage annually; and

WHEREAS, the records of the State Plant Board of Florida, the United States Department of Agriculture, and the Bureau of Customs show that each year thousands of parcels of plant material, a considerable portion of which is infested with serious foreign insects and diseases are found in, and removed from baggage from abroad; and

WHEREAS, any system of baggage inspection short of one hundred per cent would permit entry into Florida and elsewhere in the United States of plant material affected with major plant pests capable of causing serious injury to the principal agricultural crops of Florida and other states, and would require the expenditure of huge sums for their control or eradication;

THEREFORE BE IT RESOLVED by the Florida State Horticultural Society that:

1. The Society go on record as being in strong opposition to the proposed change in manner of inspection of baggage from abroad, and

2. The Society strongly recommends that the inspection of such baggage, as well as plant products from foreign countries by Customs and the Department of Agriculture be greatly strengthened for the purpose of preventing entry of destructive alien plant pests.

BE IT FURTHER RESOLVED, that the Secretary of the Society send copies of this resolution to the President of the United States, the Secretaries of the Treasury and of Agriculture, the Commissioner of Customs at Washington, the State Plant Board of Florida, and to the members of the Florida Congressional Delegation and to all international transportation lines entering Florida by air, land, or sea, and

BE IT FURTHER RESOLVED, that the President of this Society be particularly requested and urged to take this up personally with all the above, pointing out to them how inevitably the proposed course would lead to disaster.

WHEREAS, the sixty-second annual meeting of the Florida State Horticultural Society has been one of unusual pleasure and profit, and

WHEREAS, this has been made possible by the local arrangements committee who have left no stone unturned to provide every facility;

THEREFORE BE IT RESOLVED by the Florida State Horticultural Society, that the Society thank the Tampa Terrace and Hillsboro Hotels for their facilities and services, and Messrs. James S. Sparkman, Robert T. Thornton, W. Mercer Rowe, R. D. Jackson, Lemuel P. Woods, and Mr. George Dexter Sloan and Mr. A. K. Dickenson of the Chamber of Commerce for their splendid assistance.

BE IT FURTHER RESOLVED, that our very special thanks are given to the Horticultural Department of the University of Miami for their very splendid exhibit of tropical fruits and frozen fruit products.

RESOLUTION

By Col. Grove, seconded by Judge Ware and passed.

WHEREAS, a new and growing industry is being built around **Litchi chinensis** growing; and

WHEREAS, there is both a world-wide and nation-wide difference in the spelling and pronunciation of the common name of this fruit with authorities for use of both Lychee and Litchi; and

WHEREAS, the commercial growers of the state have followed in good faith the usage determined by Groff (The Lychee and Lungan), and Bulletin 109 by Mowry and Toy, revised in 1941 by Wolfe, on Tropical and Sub-tropical Florida Fruits, published by the Agricultural Extension Service, University of Florida, Florida State University, and United States Department of Agriculture Cooperating, in their advertising, package material, etc.

Therefore, be it resolved by the Krome Memorial Institute of the Florida State Horticultural Society that the preferred name for usage be Lychee.

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AUDITING

We, the members of the Auditing Committee, beg to report that we have examined the books, vouchers, statements, and reports of the treasurer of the Society and find them to be correct.

Respectfully submitted,

H. G. CLAYTON,
J. R. WINSTON,
W. L. TAIT, Chairman.

FLORIDA STATE HOI TICULTURAL SOCIETY
RALPH L. MILLER, SECRETARY-TREASURER
PLYMOUTH, FLORIDA
BALANCE SHEET
October 28, 1949
ASSETS

General Fund Assets:				
Checking Account—State Bank of Apopka		$ 118.07		
Total General Fund Assets				$ 118.07
Endowment Fund Assets:				
Savings Account—State Bank of Apopka			$ 354.49	
United States Savings Bonds, Series F (per Schedule 1):				
Maturity Value	$11,025.00			
Cost		8,158.50		
Accrued Interest to 10/28/49		350.15		
Redemption Value, 10/28/49			8,508.65	
Total Endowment Fund Assets				8,863.14
TOTAL ASSETS				$8,981.21
LIABILITIES AND SURPLUS				
Liabilities:				
General Fund Surplus:			$ 558.00	
Balance at 10/26/48				
Less Excess of Disbursements over Receipts for Period 10/26/48 to 10/28/49, (per Exhibit B)			439.93	
Balance as of 10/28/49				$ 118.07
Endowment Fund Surplus:				
Balance at 10/26/48			8,621.22	
Plus Increases for period 10/26/48 to 10/28/49				
Cash Receipts (per Exhibit B)		$ 101.47		
Increase in Redemption Value of U. S. Savings Bonds during period		140.45	241.92	
Balance as of 10/28/49				8,863.14
TOTAL LIABILITIES AND SURPLUS				$8,981.21

Necrology

Frank Stirling, immediate Past President of the Florida State Horticultural Society, passed away at his home in Davie, Florida on Saturday, November 12, 1949 after a short illness.

Frank Stirling has long been an important figure in Florida's horticulture. Born in Gallipolis, Ohio, April 13, 1878, he later came to Florida on October 6, 1909 after his schooling in Salem, Ohio and some college training in Walla Walla, Washington and some practical experience in Southern California.

His first work in Florida was on the Stetson Groves in DeLand. Then he did contract spraying of entomoginous fungi throughout the state. In 1914 when the Growers and Shippers League under Lloyd S. Tenney decided to attempt the eradication of citrus canker in Florida, Frank was put in charge of the work. His progress report to the Citrus Seminar of 1914 was one of the most alarming and dynamic talks ever made in Florida. Growers immediately sprang into action and under his able leadership, the eradication effort was soon in full swing. His rare tact and good judgment helped tremendously when the fight was being waged without the benefit of any law to support his efforts.

With the passage of the Florida Plant Act of 1915, Frank Stirling was made chief of the canker eradication division of the Plant Board which this law created. With Dr. Wilmon Newell, Plant Commissioner, Frank kept the eradication effort going at top efficiency until the last outbreak was found at Davie. He completely lost his heart to the rich soils in that section and in 1919 he resigned his position with the State Plant Board and moved to Davie where he planted and cared for groves for himself and others.

The floods of 1947 and 1948 took a terrific toll of his holdings but it never shook his confidence in that section of the state. He presided at the meetings of the Florida State Horticultural Society the first three days of November, apparently in his usual state of health, was taken sick on the tenth and passed away on the twelfth.

Frank Stirling was capable, rigidly honest, very resourceful, a hard worker and one of God's noblemen. He will be missed indeed.